OCT 2 1943

The Engineer

VOL. CLXXVI—No. 4574 28, ESSEX ST., STRAND, LONDON, W.C.2 SEPTEMBER 10, 1943

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LONDON, FRIDAY, SEPTEMBER 10, 1943.

PUBLIC NOTICES

otice is Hereby Given that

AMERICAN FLANGE and MANUFACTURING CO., Inc., SEEK LEAVE to AMEND the SPECIFICATION of LETTERS PATENT No. 548, entitled "Improvements relating to the ufacture of Threaded Sheet Metal Structures." rticulars of the proposed amendment were forth in the Official Journal (Patents), 2850, dated September 8th, 1943.

y person may give NOTICE of OPPOSI- to the amendment by leaving Patents No. 19 at the PATENT OFFICE, SOUTHAMPTON BUILDINGS, London, 2, on or before the 8th October, 1943. 8294

IGAN AND DISTRICT MINING AND TECHNICAL COLLEGE

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rther particulars and application form will t by the undersigned on receipt of a stamped ssed foolscap envelope. Last date for the t of applications, 23rd September, 1943.

J. F. S. ROSS,
Principal and Clerk to the Governing Body.

September, 1943. 8293

SITUATIONS OPEN

ES OF TESTIMONIALS, NOT ORIGINALS, UNLESS SPECIFICALLY REQUESTED.

ADVERTISERS UNDER BOX NUMBERS IN SITUATIONS OPEN SECTION.

r the benefit of applicants, the Proprietors epared to insert brief notices that vacancies filled, upon receipt of notifications from the rtisers. These notices (limited to one line) be free of charge, and co-operation is d for.

IMPORTANT

rtisers in Situations Open Column ld make themselves acquainted with terms of

STATUTORY RULES & ORDERS 1941 No. 2069

STRICTION ON ENGAGEMENT ORDER

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The Engineer

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488,400, "Improvements in or relating to Lathe and like Metal-cutting Tools."
488,764, "Improvements in Lathe and other Metal-cutting Tools."
489,897, "Face Milling Cutter."
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Continuation of Small Advts. see page

A Seven-Day Journal

The Brenner Railway Bombed

IT has been announced from the Allied Headquarters in North Africa that early on the morning of Friday, September 3rd, on the fourth anniversary of the war, and shortly before the Allied invasion of the mainland of Italy, "Flying Fortresses" bombed the southern part of the Brenner Railway and cut the railway communications between Germany and Italy. The aircraft made a round trip of nearly 1500 miles and effectively bombed railway targets at Bologna, Trento, and Bolzano. Many railway bridges were destroyed and road bridges damaged. At Bolzano landslides following the bombs caused the blanketing of the railway lines from the Brenner Pass, and much orange and yellow *débris* was observed, resulting from the fall of overhanging cliffs. At Trento both road and rail bridges over the Adige River were hit. In a special article which appeared in THE ENGINEER of February 7th, 1941, we gave a full account of the design and construction of the Brenner Railway and its operation. It was pointed out that it is the only double-tracked railway between Germany and Italy, except the old Austrian Sudbahn main line from Vienna to Trieste, which now runs through a portion of Jugoslav territory. Between Innsbruck and Brennario there are several important bridges and tunnels. The Brenner Station itself was rebuilt shortly before the war, and it has a short double-ended yard and a small engine shed for Italian locomotives. Bolzano is an important station, since it contains a marshalling yard with some fifteen to twenty tracks, and an engine depôt with repair facilities for electric locomotives. On the German side of the railway power is derived from stations of the former Austrian Federal system and from the Bavarian Walchensee hydro-electric station. On the Italian side it is taken from at least five comparatively small hydro-electric power stations.

The Late Mr. L. F. G. Butler

THE sudden death of Mr. L. F. G. Butler, the technical adviser to the aero-engine division of the Bristol Aeroplane Company, at Paddington Station on Friday, September 3rd, while on a business visit to London, deprives the British aircraft engine industry of an outstanding designer. In a Journal note of July 23rd we recorded with pleasure the recent recovery of Mr. Butler from his illness. He was at the time his of death only fifty-five years of age. After completing his education at Sexey's School, Somerset, he was apprenticed to the Bristol engineering firm of Brazil Straker and Company, where he was engaged, along with Mr. A. H. R. Fedden (now Sir Roy Fedden), on the design of the Straker Squire motor-cars. He spent a short time with the Rolls-Royce design staff, and then returned to Bristol to occupy the post of chief draughtsman at Brazil Strakers, which firm was then constructing the Rolls-Royce "Hawk" and "Falcon" engines and the 80 B.H.P. "Renault" engine, along with the redesigned Curtiss "OX" engine used during the last war. Mr. Butler designed the "Mercury" 350 H.P. double-row engine, and at a later date he became chief designer to the Cosmos Engineering Company, which, we may recall, was formed in 1918 to make that engine. Early in 1918 he designed the nine-cylinder single-row "Jupiter" engine, one or two of which were built by the Cosmos Company. In 1920 the Cosmos Company was taken over by the Bristol Aeroplane Company, Ltd., which formed a special aero-engine department. In 1921 the Bristol "Jupiter" engine was produced and soon passed its type tests. It was followed by the "Lucifer," "Pegasus," "Mercury," "Perseus," "Taurus," and "Hercules" engines, all of which bore testimony to the excellent design work of Mr. Butler. He continued to serve the firm as chief designer until 1941, when he was appointed technical adviser to the company's aero-engine division. In that year Mr. Butler was taken ill as a result of overstrain at work and he did not return to his post until late in 1942, Sir Roy Fedden having left. During the last few months he was happy and contented and had settled down to extremely valuable work on the company's latest projects and designs. His death at an early age will be widely regretted by his many friends.

Seven German Submarines Sunk

ON Monday evening, September 6th, an official announcement from the Admiralty and the Air Ministry gave particulars of a notable victory in the Bay of Biscay, where seven German submarines have recently been sunk. The sinkings took place in a series of combined actions by ships of the Royal Navy, which were supported by British and American aircraft. In the first action a group of three U boats, proceeding at full speed on the surface, were sighted by a "Sunderland" aircraft and a "Halifax" of No. 19 Group Coastal Command. The "Sunderland" flew low over a U boat and attacked with depth charges. One of these hit the conning tower, while three others rent the hull near the starboard bow. The submarine sank, leaving more than twenty of its company in the sea. On another occasion a "Liberator" aircraft of the U.S. Army Air Force attacked and mortally damaged a single enemy submarine, which was finally dispatched by a British "Halifax." Between thirty and fifty survivors were seen in the water. A few days later a further single U boat was sighted by a "Wellington" aircraft, and a second "Wellington" appeared and joined in the attack. In a few minutes the enemy submarine blew up. A third single U boat was discovered by an American "Liberator" aircraft proceeding on the surface, and was attacked with depth charges, delivered in many runs over the target. A British "Liberator" aircraft made a further attack and the submarine disappeared. Shortly after it broke surface again, heeled over, and sank, leaving wreckage and about ten men in the sea. Two days later in a combined action by sloops of the Royal Navy and by aircraft of Coastal Command and the United States Army Air Force, a notable victory was won when three further submarines were sunk, including two of the enemy's scanty force of supply submarines. In the action, which was so bravely fought, the signal of "General Chase" was given by the senior officer, and H.M.S. "Kite" opened fire at a range of more than 7 miles. One R.A.F. "Wellington" was lost and there was only one survivor. One R.A.F. "Liberator" made a forced landing, but the crew is safe.

Three American Railway Accidents

IN the period under review, three serious railway accidents have been reported from America. On Monday afternoon, August 31st, the "Lackawanna Limited," an express train bound from New York to Buffalo and Chicago, collided with a goods locomotive near Weyland, in the west of New York State. Both of the locomotives and several coaches of the express were derailed. Of the 500 passengers in the train, 27 were killed and about 150 injured. On Monday, September 6th, there happened one of the worst railway disasters in American railway history, when the famous train "Congressional Limited," bound from Washington to New York, was derailed while travelling at a speed of something like 70 m.p.h. The reports of the accident state that it was caused by a burnt-out axle-box, which caused an axle to break as the train was rounding a curve in the track near the outskirts of Philadelphia. The broken axle was at the front of the seventh coach, which, it is stated, was thrown almost vertically into the air. In its descent it dragged another passenger coach from the track, along with two dining and four Pullman cars. Of the sixteen coaches, only the first six and last two remained on the track. Eight of those damaged were in a few seconds strewn over the four tracks of the Pennsylvania Railway. One of these rolled over and over until it hit the base of a signal tower, which sheared its way through it. The total number of those killed is given as 79, and about 100 passengers were injured, many of them seriously. On the morning of September 7th another famous American train, the "Twentieth Century Limited," was wrecked at about 4.30 in the morning, while travelling from Chicago to New York at a point about 20 miles east of Syracuse. The boiler of the locomotive exploded and killed the crew of three men who were in the cab. The express left the track and the first four coaches were plunged down an embankment. Happily, there were no passenger fatalities, but three train attendants and four passengers were injured.

Bombing Germany in 1943

REVIEWING bombing operations over Germany during the fourth year of the war, an official announcement on Thursday evening, September 2nd, by Bomber Command states that 96,000 tons of bombs were dropped on Germany by aircraft of the Royal Air Force during 1943. This total is double the tonnage dropped by the Royal Air Force in the three previous years put together. The total tonnages for the four years are as follows:—1940, 3500; 1941, 20,000; 1942, 33,000; and 1943, 96,000. The tonnage dropped on the Ruhr district alone during the past year was 50,000. Among the seven German towns which were most heavily attacked were:—Hamburg, 11,000 tons; Essen, 9000; Cologne, 8000; Duisburg, 5000; Berlin, 6000; and Nüremburg, 5000 tons. Sorties made by Fighter Command in the four years were:—1940, 65,000; 1941, 173,000; 1942, 145,000; and 1943, 145,000.

The Centenary of "The Economist"

THURSDAY of last week, September 2nd, marked the centenary of our contemporary *The Economist*. A centenary luncheon was arranged at the Connaught Rooms, which was attended by representatives of the British, Dominion, and Indian Governments, the Bank of England, bankers, merchants, railway men, and authors and economists. The chair was taken by Sir Walter Layton, a former editor, who received a message of congratulation from President Roosevelt. The toast of "*The Economist*" was proposed by Sir Kingsley Wood, the Chancellor of the Exchequer, and it was supported by Mr. Montague Norman, the Governor of the Bank of England, and by Mr. Herbert Morrison, the Home Secretary. In his reply, Mr. Geoffrey Crowther, the editor, paid a tribute to all those who had contributed to its pages during the last hundred years. One result of the policy of anonymity was, he said, that little was known of the men who, besides the editors, had actually written for *The Economist* over these hundred years. Herbert Spencer was one of the first and most distinguished contributors, as were Nassau Senior and Sir Robert Giffen. In the middle period of the paper two of the most distinguished names were Herbert Asquith and Alfred Milner, while two others who were now part of the fabric of the paper were the deputy editor, Mr. Donald Tyerman, and Mr. Gilbert Layton. *The Economist*, Mr. Crowther concluded, possessed a corporate personality far stronger than one mind which took possession of all who served it. The present issue of September 4th is a centenary number, in which articles appear on such subjects as Britain in the World, Active Citizenship, Enterprise and Efficiency, the Future of Banking, the Steel Industry, an International Example, Commonwealth or Empire, the Standard of Living, Why Nationalise? Merchanting under Exchange Control, and Investment, the Second Century. In connection with the centenary celebrations a centenary volume, entitled "*The Economist*, 1843–1943," has been prepared and is obtainable from the Oxford University Press.

Engineers and the British Empire

By Professor MIDDLETON SMITH, M.Sc., M.I. Mech. E., LL.D.

No. X—(*Continued from page 182, September 3rd*)

WATER CONTROL SCHEMES IN AUSTRALIA

A STUDY of the physical and climatic conditions, especially rainfall and tropical heat (causing rapid evaporation) of the rivers, &c., of the Commonwealth, reveals the importance of water control and storage by modern engineering works. About two-thirds of the land has a rainfall of from under 10in. up to 20in.; less than 7 per cent. has a rainfall of over 40in. A feature of the rivers is the intermittent nature of their flow, causing flood and very shrunken streams. There are therefore the distinct problems of irrigation, flood prevention, water supply for domestic and stock purposes, navigation and hydro-electric power; they often become involved one with another.

The early settlers were handicapped by droughts in some years, even in the more productive regions. It soon became obvious to them that irrigation would increase the use of suitable soil for agricultural and pastural purposes. It is, however, unlikely that irrigation, although extensively carried out, will make any great proportion of the drier country profitable for cultivation. Up to 1930 some 77,813 acres of land had been irrigated after fifty years of effort and expense; that was a very small fraction of the area of the country which has less than 15in. of rainfall. It was not until 1882, nearly 100 years after the arrival of the first settlers, that the first irrigation scheme of any magnitude was launched.

A great deal of the credit for Australian irrigation is due to Alfred Deakin, who suggested a large scheme to the Victorian Parliament as far back as 1886. Deakin had persuaded a Canadian expert, George Chaffey, who had successfully carried out large irrigation works in California, to come to Australia in 1884. The first scheme utilised the water of the Murray River (1887), when four 6in. pumps were used to lift water from the river into a lagoon. It was then distributed over some 12,000 acres at Mildura. Since then millions of pounds have been expended on irrigation works. The resultant increase in settled population and productivity has been remarkable.

In 1886 the Chaffey brothers secured a grant of 50,000 acres from the Parliament of Victoria with the right to purchase up to 200,000 acres of adjoining land, subject to conditions requiring the establishment within twenty years of an irrigation settlement, and improvements, such as channels, pumping machinery, roads, bridges, &c. This Mildura scheme is regarded as the pioneer irrigation settlement in Australia. Mildura was first settled as a cattle run in 1846, but was abandoned as unprofitable. In 1894 about 3500 people were settled in Mildura and 8255 acres were under cultivation. To-day the scheme includes 45,000 acres, of which 12,000 acres are under intensive cultivation in small holdings. Mildura is the prosperous capital of the far north-west of Victoria, with a huge output of citrus fruits, currants, sultanas, and lexias—a kind of Malaga raisin.

The most gratifying result of the scheme is that seventeen families are now established where there was only one before. As a natural corollary of this increased density of the agricultural population, important towns, centres of commerce and industry, have sprung up, where, at most, only hamlets might otherwise have existed. In association with irrigation several fruit canneries have been established. There are vineyards, orchards, pastures, and fields producing cereals. It is said that some 73 per cent. of the land irrigated in Australia is in Victoria. For flood-prevention purposes, in districts of Gippsland, an immense mileage of main and tributary drains have reclaimed 100,000 acres of most fertile but low-lying country.

The largest irrigation scheme in Victoria is that connected with the Goulburn River. In order to utilise the river water, a large weir, with channel regulators, was built near Lagambie. It was completed in 1891. This structure is 925ft. long and 50ft. high. The water is released for irrigation purposes, and also to fill a large reservoir, formed by building an earthen embankment, 4¼ miles long, across a natural depression. This reservoir covers an area of more than 20 square miles.

On the upper waters of the Goulburn is another great storage, the Eildon reservoir, with a capacity of 306,000 acre-feet. The height of the dam is 140ft. above the river bed. The catchment area is 1500 square miles. Storage was commenced in 1922. Hydro-electric supply is obtained. The Goulburn system serves 1,300,000 acres, the aggregate length of the main channels is 212 miles, and there are 2280 miles of distributing channels.

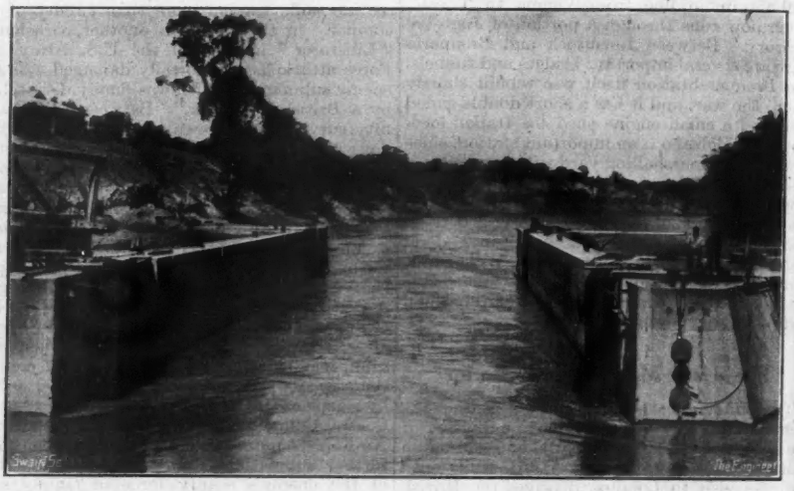
THE MURRAY RIVER CONSERVATION SCHEME

By far the most important water control scheme carried out in Australia has been that connected with the Murray River. This river and its tributaries are the only great inland rivers in the Commonwealth. The Murray has a length of 1520 miles from its source in the Australian Alps to the sea, and for 1200 miles it marks the boundary of New South Wales and Victoria. The Murrumbidgee (1000 miles long) and the Darling are its two great tributaries which flow in from New South Wales. During winter months the Murray and its tributaries have at times a total navigable length of about 3200 miles for small shallow-draught steamers. The basin of the river and tributaries covers an area equal to double that of France.

The conservation scheme involved the construction of the huge Hume dam across the river, some 1300 miles from the sea, and a series of weirs (with locks for navigation) at intervals along the stream, with great barrages to exclude salt water from the river mouth. The Commonwealth Government combined with those of New South Wales, Victoria, and South Australia to bear the cost. These works have improved nagivation, irrigated about 2,000,000 acres, supplied water for stock raising and domestic purposes, and can provide about 25,000 kW of electric energy.

It was decided in 1914 to appoint a permanent Commission to carry out ambitious plans and to make general regulations for the disposal of the water. The proposals were that a dam should be built on the Upper Murray with supplementary storage at Lake Victoria. There were also to be twenty-six weirs and locks along the Murray for a distance of over 1000 miles, and nine weirs and locks on another reach.

The original estimate (made before 1914), for what has been called "The Great Murray Conservation Scheme," was £5,000,000, but in 1936 it was estimated that the total cost of locks and weirs for the Lake Victoria and Hume reservoir storages would be £12,000,000.



LOCK NO. 11 ON RIVER MURRAY AT EUSTON

In 1933 the Commission came to the conclusion that the expense involved by these proposals was unwarranted, and smaller works carried out make it clear that, to a great extent, navigation had to give place to irrigation.

Extensive works that were completed by June, 1940, were the Hume reservoir, Yarrawonga weir, Lake Victoria storage, thirteen locks and weirs, and barrages across the five channels at the mouth of the Murray in South Australia. These works allow permanent navigation from the mouth of the river for a distance of about 600 miles. It is now navigable for 1066 miles from its mouth for eight months by steamers drawing 5ft.

The Hume reservoir covers about 52 square miles. The principal work was the construction of a huge dam, 5280ft. long, which rises to a height of 150ft. above the river bed and is 32ft. wide at the crest where a roadway has been provided. The dam has an earthen section of 4238ft., with a core wall of concrete reaching down to bedrock. There is a concrete spillway, including turbine wells and outlet works, of 1042ft. The storage capacity of the scheme is 1,250,000

acre-feet—1 acre-foot equals 272,250 gallons. This scheme improves navigability. There are thirteen weirs, each with a lock for navigation. A diversion weir at Yarrawonga is 1600ft. long and raises the level of the water 20ft. above the ordinary summer river level.

BURRINJUCK DAM, NEW SOUTH WALES

This supplies water for irrigation, &c., for 400,000 acres in Victoria and 1,100,000 acres in New South Wales.

The diversion weir at Yarrawonga consists of three sections—a concrete weir, 369ft. long, across the main river at the south end; an earthen dam, 1144ft. long, across the river flats; and a structure, 87ft. across a flood channel at the north end; a total length of 1600ft. The weir raises the level of the water 20ft. above the ordinary summer river level, and provides adequate supplies of water for 400,000 acres in Victoria and 1,100,000 acres in New South Wales.

The summer level of the Murray River was raised 16ft. by converting a natural depression into the Kow Swamp reservoir, which holds 40,860 acre-feet of water, the off-take for which is above the weir. A lock provides passage for river craft.

Other irrigation systems in Victoria along the Murray include several that depend on pumping. That in the Tresco district has a channel mileage of 18, to supply 3840 acres; the Nyah irrigation area includes 3750 acres, with length of channels 35 miles; the Merbein irrigation area has 8500 acres with channels 54 miles long; the Redoliffe irrigation settlement contains 18,000 acres, the channels being 125 miles long.

THE MURRUMBIDGEE SCHEME

The large-scale dam on the Murrumbidgee River is 200ft. high and 765ft. crest length. It banks the water back into the mountain. The catchment area is 5000 square miles. The township at the dam is 1200ft. above sea level, and can be reached by rail, being 202 miles from Sydney. The Murrumbidgee passes along its natural channel for about 240 miles to Berembed, where a weir across the river diverts it into the main canal, which at its offtake has a capacity of 1600 cusecs. The main canal runs for a distance of 96½ miles from the offtake. There is a complete system of reticulation and drainage channels, bridges, regulators, &c., and roads to serve every farm. The drainage channels are 745 miles long, and the canals and reticulation supply channels and pipe lines total 809 miles. In addition, there are about 377 miles of supply channels, which are really extensions of the Murrumbidgee irrigation areas, but the land is under other authorities.

The hydro-electric power station at the dam has an installation of 20,000 kW. Power is transmitted over 400 miles of 66,000-volt lines. The scheme regulates the flow of the river to serve the interests of riparian proprietors over 730 miles of river frontage. Trusts have been formed to supply water to several towns, also domestic and stock supplies for land holders for an area over 4,000,000 acres. In addition, there are areas totalling nearly 1,000,000 acres, constituted to receive water benefits.

The Berembed weir and main canal cost £1,353,947, which, together with the cost of the big dam, development works, town water supply, &c., absorbed a total of practically £8,000,000.

In South Australia the Tod River scheme supplies by means of pipe lines nearly 10,000 miles of territory west of Spencer's Gulf with water for domestic and stock purposes. An even greater work is the construction of a 240-mile pipe line, to carry water from the Murray River. It is designed to supply 1200 million gallons a year to Whyalla, Spencer's Gulf, and 900 million gallons to northern districts in South Australia. This will enable blast furnaces to be installed at Whyalla and the establishment of a shipbuilding industry there.

DOMESTIC AND STOCK SUPPLY SYSTEMS

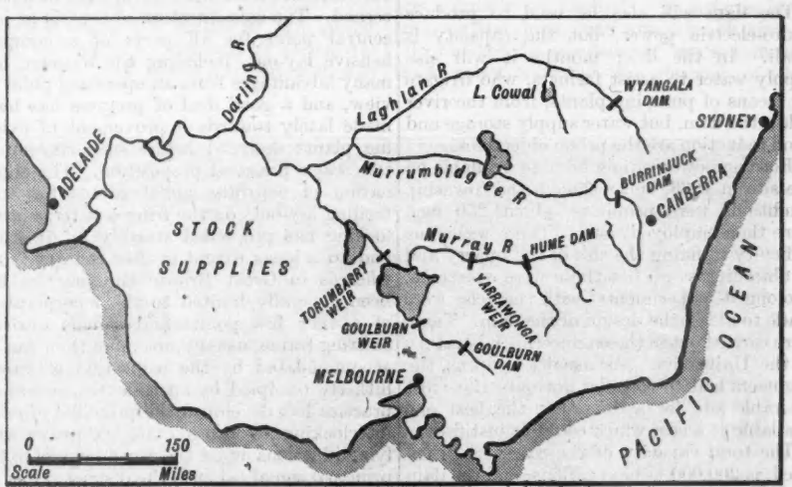
Other provision has been made for extensive and efficient supplies of water for domestic and stock purposes. Victoria has been involved in large water storage schemes, with a capacity of nearly 2,000,000 acre-feet, or, say, 545,000 million gallons.

There are 6270 miles of Government connecting channels and the farmers have provided another 6000 miles in the Wimmera-Mallee gravitation channel system. The total storage is well over 56,000,000 gallons. A number of reservoirs supply storage, the largest being Lake Lonsdale, with a capacity of well over 14,000,000 gallons. It lies at the foot of the precipitous heights of the Grampian Mountains, about 150 miles north-west of Melbourne. Every farm must have a storage tank of capacity 2500 cubic yards, and every town is provided with suitable storage basins. Some of the farms are as far as 300 miles from the headworks reservoirs. This is believed to be the most extensive scheme of its kind in the world. The Northern Mallee water supply system supplies 1,532,000 acres from 109 bores and 260 excavated tanks. These are examples of the efforts made in the Commonwealth to aid farmers.

THE CANNING DAM

The residents in the City of Perth, Western Australia, for many years had to depend on artesian bores for water supply. There was the possibility of obtaining a larger supply from the near Darling ranges. Churchman's Brook reservoir was formed a few years ago, but in 1933 work was commenced on a big dam, situated 32 miles from Perth, on the Canning River. The catchment area is 282 square miles and the reservoir formed by the dam covers about 1240 acres, and contains 20,250 million gallons. The distance round the water's edge is about 24 miles. The quantity of concrete used was about 350,000 cubic yards; 60,000 tons of cement, mostly of Western Australian manufacture, were supplied.

The site of the dam is a deep, rocky gorge, with excellent solid rock foundations. The "chuting" system for concrete was employed; a steel cable, from the top of a steel tower, 235ft. high, was suspended across the valley; concrete flowed into the required position at the rate of 280 cubic yards per



BASIN OF THE MURRAY RIVER

eight-hour shift. Stone was available near to the dam site. The greatest width at stream bed is 170ft., the wall at the top is 21ft. wide. The total cost of the dam was about £1,260,000.

The Somerset Dam

The purpose of this dam is twofold, namely, to provide storage for the water supply at Brisbane and Ipswich, and to provide, in addition, a reservoir to intercept and hold flood waters such as have caused serious damage to the two cities in past years. It was estimated that the total cost of the works upon completion would be about £2,000,000, part of which was provided by an unemployment relief grant from the Commonwealth Government. The remainder of the expense was to be shared by the State of New South Wales, the Brisbane City Council, and the Ipswich City Council. The chief engineer of the work was Mr. W. H. R. Nimmo, M. Inst. C.E.

There had been several previous proposals for the mitigation of floods from the Brisbane River and its tributaries. In 1893 two major floods devastated the cities within a fortnight; both floods reached a height of 31ft. at the Post Office gauge. There was also the consideration of the problem of water supply storage. After careful surveys and inspection, it was estimated that damage caused by floods similar to those of 1893 would total over £3,000,000, and there was the additional danger of damage to health, for the effects of a flood in a sewered city are very severe.

It was estimated that a storage capacity of 55 million gallons would be sufficient to supply the needs of Brisbane and Ipswich until about 1980, and the dam was designed on that basis.

In addition to the Somerset dam, there were other works on the Brisbane River, including the widening of the river at Kangaroo Point.

The maximum storage capacity required for water supply in 1980 is estimated at about 25 per cent. of the capacity of the dam. The level of the water will be kept as low as possible to deal with flood waters, but in the dry years the lake will be kept at a higher level than in the wet years.

The dam will also be used to produce hydro-electric power, but the capacity is small. In the drier months it will also supply water to assist farmers, who irrigate by means of pumping plants, from the river below the dam, but water supply storage and flood reduction are the prime objectives.

Electric power supply became available on the site in 1936, and although the township conditions were primitive, about 250 men were then employed there. There was some difficulty in fixing the site of the quarry and in obtaining sand, but these were overcome. Prolonged experiments with models were made to aid in the design of the dam. These were carried out in the engineering laboratory of the University. As usually happens, the engineers had to consider not only the most desirable site for a dam, but the best one available at a cost which could be justified.

The total capacity of the reservoir, when filled, is 200,000 million gallons, and the dam is designed for an overflow of 2ft. of water above the highest portions, with a discharge capacity of 165,000 cusecs. There are also arrangements to discharge water from the dam at rates up to 60,000 cusecs.

The dam is of the gravity type, straight in plan, 1010ft. long, and it contains 300,000 cubic yards of concrete, weighing 540,000 tons. The foundation is blue porphyrite rock and the total quantity of earth and rock excavated in preparing the foundation was 160,000 cubic yards. A trench was excavated to a level of 10ft. below the general level of the foundation, and was filled with rich concrete. It forms a cut-off wall to act as a seal to prevent the passage of water under the dam. To supply water for a hydro-electric plant a 9ft. diameter steel-lined pipe was provided.

The whole of the plant at the dam was electrically driven, the power being supplied at 33,000 volts from the transmission line fed by the Brisbane City Council station. Water is pumped from the river to tanks of 100,000 gallons capacity to serve the township. This township was planned for housing and general welfare of the community. There were provided a police station, a school, with four teachers and over 100 children, church buildings, and business premises, such as post office, doctors' offices, &c., and a recreation hall. The resident engineer was placed in charge of the township, which includes a swimming pool and a golf course for the population of nearly 900.

The following table gives statistics of a number of Australian concrete dams:—

Statistics of Australian Dams

Name of dam.	State.	Type.	Height in feet.	Crest length in feet.	Quantity of concrete in cubic yds.	Storage capacity in acre-feet.	Storage capacity per cubic yard of concrete, acre-feet.
Somerset	Queensland	Gravity	163	1,010	300,000	725,000	2·42
Lake Manchester	Queensland	Gravity	112	640	54,000	21,000	0·38
Avon	N.S.W.	Gravity	230	728	221,585	174,000	0·81
Burrinjuck	N.S.W.	Gravity	200	765	320,000	772,000	2·41
Cataract	N.S.W.	Gravity	187	811	148,000	76,400	0·52
Cordeaux	N.S.W.	Gravity	185	1,327	218,440	76,000	0·35
Hume	N.S.W.	Gravity	150	1,042	564,000	1,250,000	—
Nepean	N.S.W.	Gravity	246	700	309,843	66,000	0·21
Woronora	N.S.W.	Gravity	211	1,330	373,240	57,000	0·15
Wyangala	N.S.W.	Gravity	190	1,000	243,000	304,000	1·25
Glenmaggie	Victoria	Gravity	100	1,050	100,000	150,000	1·50
Canning	W. Australia	Gravity	318	1,645	350,000	75,800	0·22
Great Lake	Tasmania	Multiple arch	40	1,180	11,000	1,146,000	—

The Somerset dam heads the list in storage per cubic yard of concrete, but there are others longer and higher. The Hume dam in New South Wales includes a long earthern section containing 4,200,000 cubic yards of fill on the Victorian side..

(To be continued)

Modern Railway Signalling Practice in America

By O. S. NOCK, A.C.G.I., B.Sc., A.M.I. Mech. E.

No. III—*(Continued from page 193, September 3rd)*

Remote Control

SOME of the signalling installations discussed in the previous instalment of this series include points and signals at a considerable distance from the control machines concerned. The concentration of control at one central point for all parts of a comprehensive lay-out, including the outliers, has many advantages from an operating point of view, and a good deal of progress has been made lately towards improvement of existing plants designed before such concentration was a practical proposition. The elimination of separate signal cabins for controlling lay-outs on the fringes of large interlocking has proceeded steadily in America, and to a lesser extent in this country; but whereas in Great Britain the practice has been generally limited to the incorporation of a very few points and signals into an existing frame, usually not more than can be accommodated by the utilisation of spaces hitherto occupied by spare levers, American practice has developed the principle of relay interlocking to bring quite extensive outlying junctions under the direct control of the principal signal cabin in the district. Fig. 20 shows a typical cabin interior, with a small switch panel for remote control mounted alongside the power frame controlling a major interlocking.

A good example of the type of lay-out that is now being brought under remote control is shown in Fig. 21. Originally the interlockings at locations X and Y were controlled by separate signal cabins, but then the cabin at X was destroyed by fire. Instead of replacing this cabin a remote control scheme was installed, bringing the entire lay-out at X under the control of the signalman at Y. A compact switch panel, with non-interlocked thumb switches, was fitted in cabin Y, and far from throwing any particular strain upon the signalman there, this rearrangement yielded a noticeable operating improvement, owing to the control of these two adjacent interlockings from the one cabin by the same man. Towards this improvement the illuminated diagram contributed a great deal. From the economic standpoint the first cost of this remote control installation was greater than that of replacing the damaged original plant, but in operation and maintenance a saving of nearly 70 per cent. per annum on this additional cost was realised. Locations X and Y are about 3 miles apart, and all the points and signals at X are controlled by direct line.

In practice the cost of cable is usually the factor limiting the distance from the cabin at which lay-outs of this kind can be worked, and in each individual case studied every possible means of reducing the number of line wires is worth investigating. The use of coded control has solved many difficult problems, but so elaborate and relatively expensive a means is not worth while where it is merely a matter of controlling one small interlocking from another point some 3 or 4 miles away. The subject of coded control will be discussed in detail later in this series of articles. A further interesting example of direct-line remote control is illustrated in Fig. 22. The route in question is not a very

busy one, handling only about sixteen trains daily, and is controlled with ordinary manual block; to reduce operating expenses it was decided to dispense with the signal cabin at location K, where double track ended, and to control the junction from the signal cabin at the toe of the switch to overcome the effect of the spring, and so open the points; this centre-point deflection is used to actuate the facing point lock plunger. At a position about half way between the toe and the heel of the switch at C a connection by rodding is

FIG. 20—SWITCH PANEL FOR REMOTE CONTROL

at L. Trains run in one direction only on each road in the double-track section, as shown in Fig. 22, and so it was possible to use a spring switch lay-out for the points A, with the road normally set for a left-hand turnout. For passenger traffic it is, of course, necessary for the points to be bolted for a movement over them in the facing direction, and at the same time the points require to be trailable. The facing point lock mechanism used for such lay-outs is shown in Fig. 23.

The spring mechanism housed in the casing shown between the rails holds the points normally against the left-hand stock rail. With the points in this position the facing point lock blade A is intersected by a plunger in the lock casting B, and the points are made to a stretcher bar, and when trailing takes place this bar will move laterally between ¼in. and 1in. according to the type of switch. This movement, which takes place before there is any tendency for the points to open, is magnified by a gain-stroke bell crank at D; the motion thus imparted to the connecting-rod E withdraws the lock plunger, in time for the points to move under the trailing action of the oncoming locomotive. To prevent the points from returning sharply after the passage of each wheel an oil buffer device is included at F; this retards the motion of the switches when returning under the action of the spring. When the points are restored to normal the facing point lock plunger is automatically replaced and electric detection contacts remake, proving that the plunger is home and that the closed switch blade is correctly against the stock rail.

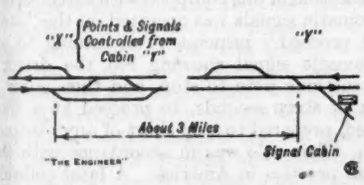


FIG. 21

thus bolted securely. With this safeguard passenger trains can be operated over the points in the facing direction at the highest speeds. The normal route of traffic passing over these points in the trailing direction is, however, from the left-hand road, as shown in the engraving Fig. 22, and during the passage of a train the switches are forced over from their normal position to the reverse, against the spring. Provision has thus to be made in the mechanism for the automatic withdrawal of the facing point lock plunger so as to render the switch tongues free to move during a trailing movement. When a pair of spring points are trailed the switch rails deflect a considerable amount, at their centre point, before sufficient force is exerted

AUTOMATIC INTERLOCKINGS

From these remotely controlled lay-outs we pass on to consideration of purely automatic interlockings. In America crossings on the level of one railway over another are fairly common, and it is to deal with instances of this kind that the American system of automatic interlocking has been largely developed. But while lay-outs of this character are very few in Great Britain, though including the famous L.M.S.-L.N.E.R. crossing at Newark-on-Trent, there are other cases to which the principle is readily applicable. Fig. 24 shows an example of gauntleted tracks, such as are to be found over viaducts on routes originally single-tracked, but later doubled for the bulk of their length. In the operation of traffic the viaduct cannot be other than a bottleneck, and in some cases

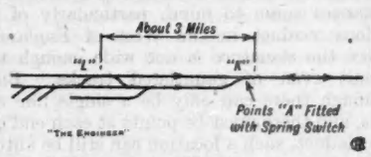


FIG. 22

single-line working is employed between the block posts A and B on either side of it. A more flexible arrangement is to continue the double track to the viaduct approaches and install a special block post to control traffic over the bridge itself. The purpose of an automatic interlocking at such a place is to retain the flexibility of the double-track between A and B, while avoiding the expense of a continuously staffed block post at the viaduct itself.

Four signals only are required, as shown in Fig. 24, and these are normally at danger; they are not connected in any way with the block working, which is ordinary manual block between A and B. The working between these two boxes is just as though the double track were continuous throughout. The up and down home signals are normally at danger, and their respective "distants" are normally at caution. An approaching train on the down road enters track circuit D1, and the de-energising of the associated track relay initiates the clearing of the

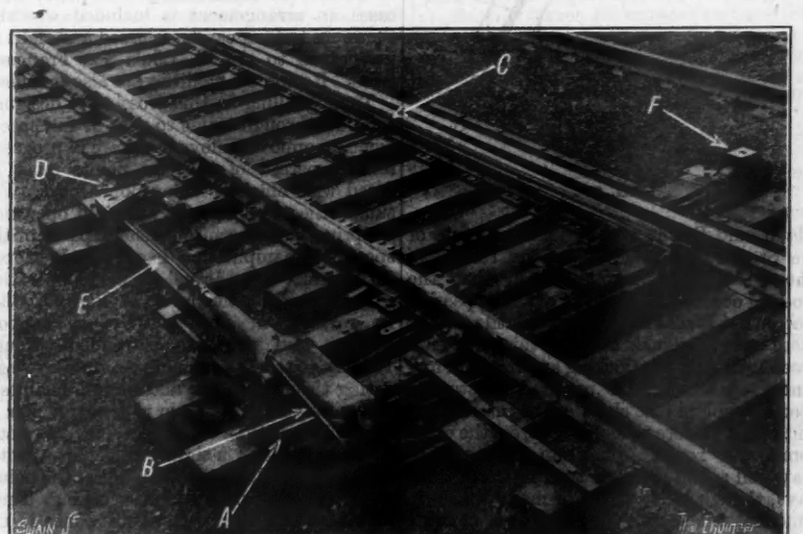


FIG. 23—FACING POINT LOCK MECHANISM

signals, providing that no train on the up road is near enough to the gauntlet to have entered upon track circuit U1. The down train, on entering track circuit D1, not only causes the down home and distant signals to clear; it also locks the up signals in the danger position. The approach track circuits D1 and U1 are made so long that if the road is clear through the gauntlet the appropriate signals are "pulled off" early enough to permit the train to approach and pass over the viaduct without any slackening in speed. Instances come to mind, particularly of a famous viaduct in the West of England, where the structure is not wide enough to permit even of gauntleted tracks. But although there can only be a single line of rails, and there must be points at each end of the viaduct, such a location can still be automatically operated. The points can be laid in with spring switches and equipped with facing point locks of the type shown in Fig. 23, leaving the signals to be automatically controlled as in Fig. 24.

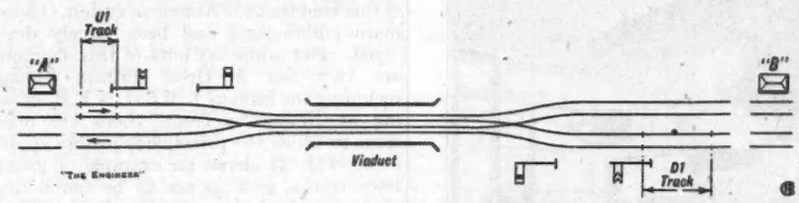


FIG. 24—SIGNALLING OF GAUNTLET TRACKS OVER VIADUCT

The case of gauntleted tracks has been quoted as an instance of automatic interlocking that is readily applicable to British conditions. To what extent the principle has been developed in America is shown by reference to the extensive lay-out at Holdenville, Oklahoma, shown in Fig. 25, where a single-track route of the Chicago, Rock Island, and Pacific crosses a similar route of the St. Louis–San Francisco on the level. The position is complicated in that the crossing occurs in the middle of a long passing loop on the Rock Island route. Until recently there were no signals at all at this particular crossing and no interlocking apparatus of any kind; all trains were required to stop at specified points just short of the intersection and whistle before proceeding across the other company's route. Such an arrangement may well sound somewhat primitive in these days, though it is typical of many places in America, where neither route at a crossing is a particularly busy one. The decision to install automatic signals at this crossing came as a result of the acceleration of some through freight trains, to which the regulation stop at Holdenville caused too much delay. The new signals are controlled on the same general principle as in the simple case previously discussed, though a number of special provisions have to be included on account of the more extensive track lay-out.

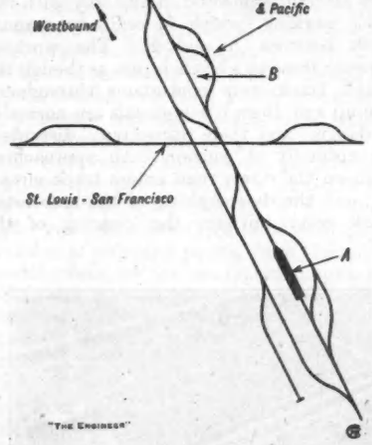


FIG. 25

As previously explained, the first train to arrive on any one of the approach-control track circuit secures the road over the crossing and locks it against all conflicting movements. On the Rock Island tracks there are, quite apart from the level crossing with the St. Louis–San Francisco line, a number of alternative paths; for example, a train standing at A can proceed westward *viâ* the main line or through the crossover road into the loop in order to avoid an eastbound train standing, or carrying out shunting movements at B. All the points in the lay-out are hand thrown, and none is interlocked, and providing the right of way is established over the crossing the signals are cleared according to the setting of the various points, all of which are electrically detected. In the case just mentioned, if a train were standing at B and an opposing train at A had arrived earlier and secured the right of way, the westbound signal for train A would not clear until the crossover road was correctly set to take train A *viâ* the loop and so clear of train B. In the case of freight trains having shunting work to do it might easily happen that a Rock Island train had duly arrived and established the right of way over the level crossing; but some time before shunting work was finished at A a St. Louis–San Francisco train arrived and was ready to cross over immediately. To meet such cases an arrangement is included whereby the route locking can be released and right of way given to the St. Louis–San Francisco train. Reciprocal facilities are also included.

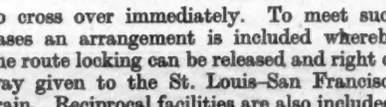


FIG. 26

The signalling at this crossing is designed to allow through trains to pass at full speed, when no opposing movements are in progress, and to permit of this the points must be fitted with efficient facing point locks. For such duties, and also for the hand operation of spring points, a mechanism capable of the speediest manipulation has been developed in America. The actual means of operation can be seen in the lever in Fig. 23, that is resting in the jaws of a support casting, and needs to be pulled through 180 deg. to throw the points; ample leverage, acting through a rack and pinion, enables a man of average physique to throw a pair of points in less than a second. Fig. 23 relates to spring points; a similar mechanism, without the trailable feature, is used for the points at Holdenville automatic interlocking. There is, however, one important difference in the two cases; in a spring switch lay-out the points are only locked in the normal position, whereas at Holdenville and similar places facing movements are made with points in either the normal or reverse position; the hand-operated mechanism thus has to include point locking in both these positions. In this country, where unidirectional running roads are generally preferred at passing loops on single lines of railway, a somewhat lavish provision of mechanical signalling is still to be seen at many places. Two signal cabins, one at each end of the loop, are used more often than not. Recently certain of these cabins have been eliminated, by concentrating control of the loops at one end and operating the points at the far end electrically by hand generator; spring switches equipped with mechanical facing point locks of the type shown in Fig. 23 would seem to provide a still more economical solution.

PERMISSIVE SIGNALS

Ordinary automatic signalling, on double or quadruple-tracked lines, has long since ceased to be a novelty both here and in America; but the action to be taken by the driver of a train coming to an automatic signal displaying the "danger" aspect has been, and still is, the subject of considerable controversy. Fig. 26 shows one track of a double-line railway equipped with three-aspect automatic colour-light signals; two trains are shown, and the aspects displayed by the various signals are indicated by the letters in the circles. In this country the first section of line equipped with three-aspect automatic signals was operated on the "stop and proceed" principle; on coming to an automatic signal showing red the driver's instructions were to stop, and then, after a halt of sixty seconds, to proceed at a slow speed, prepared to stop short of any obstruction. This rule was in accordance with the usual practice in America. A fatal collision on the outskirts of London caused the "stop and proceed" rule to be reconsidered, and recent practice has been modified, making the procedure rather more elaborate. The enginemen of a train reaching an automatic signal at "danger" now have to telephone to the nearest signal-box for instructions and may not proceed until a sign fixed below the signal lights up and displays an illuminated letter "P" (proceed). In Great Britain almost all installations of automatic signalling have been made on lines carrying a heavy suburban traffic or on high-speed main lines, as between York and Darlington, L.N.E.R. In America automatic signals have been installed on both single and double-track routes traversing the Rockies, in many cases where no signals at all had previously been used. On heavy ascending gradients the

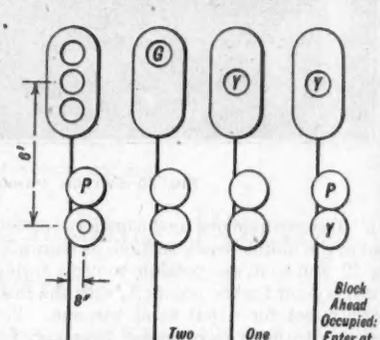


FIG. 27

problem of the "danger" indication becomes more acute than ever, as it is obviously undesirable to stop a very heavy train on the gradient if it can possibly be avoided.

In this respect an installation recently put into commission on the Union Pacific Railroad is of interest. From Cheyenne, Wyoming, the double-tracked main line to the West ascends on gradients varying between 1 in 65 and 1 in 81 for 28 miles, attaining an altitude of 8000ft. at the Continental divide. Three-aspect automatic colour-light signals have been installed, spaced at intervals to suit the normal speeds of the trains. On the eastbound track, where speed is high, there are eleven signals on this 28-mile stretch, and with these traffic is operated under the ordinary "stop-and-proceed" rule. On the westbound track, in order to provide for closer headway between following trains, the signals are placed closer together, there being twenty-two in this same 28 miles of railway. On so steep an incline speeds could never be high, and with the object of reducing train delays to a minimum special arrangements have been introduced so as to permit of a train passing an automatic signal that would ordinarily be showing "danger." When one and two blocks ahead are clear the signals display the usual "yellow" and "green" aspect respectively; when the block immediately ahead is occupied the main signal shows the yellow aspect, but in addition, an auxiliary colour-light unit below is illuminated, showing a second yellow light—see Fig. 27. This "yellow-over-yellow" aspect indicates "proceed at reduced speed," and after passing it a driver should have his train under control so that he can stop short of any train, obstruction, or anything else that may require the speed to be further reduced. The "yellow-over-yellow" aspect was chosen so as to obviate the need for drivers to pass a "red" without stopping. This first application of "non-stop" permissive signals has proved very successful in service, so much so that the Union Pacific has decided to adopt the principle on all new and reconstructed signalling installations in places where the gradient is 1 in 200 or steeper.

The mention of obstructions other than trains leads on to an interesting accessory used on certain mountain sections. Where high cliffs or slopes, including loose scree, overhang the railway there is often a danger from falling rocks. In Scotland the former Caledonian Railway installed a mechanical device for giving warning of such danger on certain sections of the Callander and Oban line; but in America it is sometimes necessary to provide such warning on lines that are track circuited and equipped with automatic signals. At the danger spots wire fences are erected, of about 4in. mesh netting; throughout the fences the panels of the net, separated by wood or steel uprights, are connected and held taut by heavy tension springs at each end. A detector cable connects with every panel throughout the fence, and if any panel is struck by a falling rock and pushed out of line by about 8in. or 10in., the movement imparted to the detector cable operates the trigger of an electric circuit controller, causing the latter to open certain contacts. As a result of such distortion or deflection of the fence all the signals reading over the particular stretch of line are set in their most restrictive aspect.

(To be continued)

THE LATE MR. R. G. WOODWARD.—We record with regret the death, on August 27th, of Mr. Robert Guthrie Woodward, a director of Edgar Allen and Co., Ltd., Sheffield. He was sixty-two years of age, and had been associated with the firm for forty-five years.

Dehydration of Food by Radio-Frequency Energy*

By VERNON W. SHERMAN†

THE industrial electronics division of the Federal Telephone and Radio Corporation, in co-operation with the Office of the Quartermaster-General of the United States Army, has developed a process of dehydrating food by means of radio-frequency energy. The process makes possible, for the first time, removal of 99 per cent. of the moisture content from a compressed vegetable block.

Conventional methods of dehydration rely on heat and forced air to remove water from vegetables. With these older processes it is possible to remove 95 per cent. of the moisture content without injury to the product. Vegetables so dehydrated can be reconstituted, *i.e.*, the normal water content can be restored by soaking in water, the vegetables returning to their original state and retaining their natural colour and flavour.

Many root or semi-perishable vegetables, including beets, carrots, cabbage, onions, and potatoes, with a residual moisture content of 5 per cent., will keep only a few weeks in humid atmospheres and they cannot be packed satisfactorily, inasmuch as the moisture present causes mould to form and makes them inedible. Consequently, attempts have been made to reduce the moisture content further. With conventional forced hot air drying many vegetables develop a tough, blackened skin known as "case hardening" when the moisture content is reduced below 5 per cent. "Case hardening" is a permanent change and prevents reconstitution to their former freshness and colour.

The electronic dehydration method developed by Federal not only makes it possible to remove 99 per cent. of the moisture, but it also permits this high degree of dehydration after the vegetables have been compressed into a small block or briquette, 6in. by 3in. by ¾in. As will be recognised by those familiar with dehydration processes, compression of vegetables prior to total dehydration is an unprecedented procedure. Other processes require exposure of as much of the vegetable surface as possible to facilitate evaporation.

With all but 1 per cent. of the moisture removed, it is possible to pack all types of dehydrated vegetables in sealed containers and transport them to any part of the world without danger of decomposition. Extensive studies have shown that the length of time vegetables may be kept in good condition increases very greatly as the moisture content approaches 1 per cent. Evidence now indicates that vegetables dehydrated by the electronic method will not deteriorate over a period of one to two years even in hot, humid climates.

Vegetables reconstituted after electronic dehydration may be cooked and served the same as fresh vegetables. Reconstitution is accomplished by soaking the vegetables in water. They then return to their original colour and consistency and retain their normal taste and aroma. The vitamin content of electronically dehydrated vegetables is especially high, due apparently to the much shorter processing time.

The exact method of dehydration cannot be disclosed at present. Briefly, however, 80 per cent. of the moisture is removed by conventional methods, leaving the vegetables pliable, but without formation of "case hardening." The vegetables are then compressed into bricks and the remaining moisture is removed electronically, after which they are ready to be wrapped in paper, wax coated, packed and shipped. The whole procedure is well adapted to automatic straight-line production. Laboratory results show that 1 lb. of water may be removed electronically with less than 1 kWh of energy, a figure which is economically good in comparison with other methods.

In addition to the above-mentioned vegetables, dried whole milk also has had its moisture content reduced electronically from 2 per cent. to 1 per cent. This small difference makes it possible to ship dried whole milk without danger of its butter fat content becoming rancid. Unlike dried skim milk, dried whole milk can be reconstituted to be as palatable and nutritious as fresh milk.

Aside from the importance of this electronic dehydration achievement, the results of which are especially timely in connection with the transportation of food abroad, it is interesting to note that the process represents another of the many outgrowths of fundamental research and development in industry. Electronic dehydration of foodstuffs was undertaken by the Federal Corporation as a co-operative and non-remunerative project to aid in the war effort.

* Reprinted from *Electrical Communication*, the journal of the International Telephone and Telegraph Corporation, New York.

† Federal Telephone and Radio Corporation, Newark, New Jersey.

Crewe Centenary Celebrations

DURING the present year the L.M.S. locomotive works at Crewe celebrates its hundredth year. In view of the intensive work now going on in connection with the magnificent railway war effort, time cannot be spared to celebrate this centenary in the fashion warranted by its importance, an event which must, of necessity, take place after victory has been won. On Thursday, September 2nd, an official visit was paid to the Crewe works by Sir Thomas Royden, who met at the works many retired and present-day locomotive engineers. Crewe is indelibly associated with the long history of the steam locomotive, and engineers trained in its shops are to be found all over the world. Some of the more outstanding engines built at Crewe may be mentioned. The first Crewe-built engine was the "Columbine," which is now in the Railway Museum at York. Another famous locomotive was the "Lady of the Lake," which was awarded the Gold Medal at the International Exhibition of 1862. The "Queen Empress" was shown at the Chicago Exhibition of 1893, while the "Hardwicke," in 1895, two years later, achieved the remarkable speed of 67·2 m.p.h. in the race to Scotland. The "Charles Dickens" was another famous Crewe locomotive, which ran a million miles in ten years, and had a total mileage of 2,345,107 to its credit. The "Royal Scot" of 1935 will be remembered by all who visited the New York Fair, while the "Coronation" of 1937 was the holder of the world's non-stop record, and toured some of the principal railways in North America. These engines, although outstanding, are only a very few of the large number of 6623 locomotives constructed at Crewe since the year 1843. Under wartime conditions, the Crewe locomotive works is engaged on other tasks besides engine building. A large staff of men and women are engaged on the work of repairing 2000 locomotives, while supplying the needs of the railway as regards points, crossings, signals, and the repair of L.M.S. docks and harbour plant, besides other railway activities. Crewe locomotive men and women are fully engaged at the present time in keeping L.M.S. locomotives in service, so that they can cover additional mileages and haul the ever-increasing war freights. Only in this way can the London Midland and Scottish Railway maintain its mighty contribution to the nation's war effort.

BRITISH-TRAINED INDIAN MECHANICS.—Under a scheme initiated by the Ministry of Labour, a number of Indian mechanics have come to this country for special training and have since returned to take up staff jobs in Indian workshops. Out of 354 men sent to England under the scheme, 203 have returned to India, and many have secured employment in the various technical branches of civil and defence industries. Four men, whose previous salaries were between Rs. 40 and Rs. 70 per month, are now commissioned officers in the Corps of Indian Engineers, on a starting salary of Rs. 445 per month. A jig and tool draughtsman, formerly earning Rs. 2-10 a day in an Indian railway, is at present the head of the jig and tool department of a Calcutta firm on Rs. 300 per month.

Some Tensile Shock Properties of Carbon Steels*

By F. V. WARNOCK, Ph.D., F.R.C.Sc.I., M.I. Mech. E., and J. B. BRENNAN, Ph.D.

The Testing Machine

FIG. 1 is a diagrammatic representation of the machine. A rotating crank C of variable throw is attached to a wheel B through an adjustable turnbuckle L by means of a wire rope. Another wheel W, keyed to the same shaft as B, is attached in a similar way to the mass X, which is connected through an automatic gripping and releasing device to the arresting crosshead M. The specimen S is attached at one end of the arresting crosshead and at the other end to the tup T. Rotation of crank C causes M, S, and T to become attached to X and then lifted vertically. At any predetermined height M, S, and T, released automatically, fall freely on to the anvil R, contact being made through suitable striking surfaces on M and R. The specimen is then subjected to a momentary tensile stress due to sudden retardation of the tup. By driving the crank C from a suitable motor, this cycle of operations may be repeated until fracture of the specimen occurs. The driving gear used was of such a nature that forty shocks per minute took place throughout the multi-shock tests.

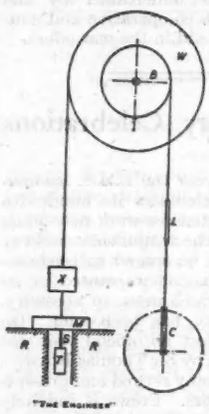
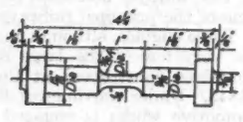


FIG. 1—*Diagrammatic Representation of the Testing Machine*

Consideration of the type of loading employed led to the word "shock" being substituted for "impact," which implies collision between two bodies, one of which is the test piece, and has been interpreted as such by many experimenters when investigating the effects of suddenly applied stress.

The Specimen

The dimensions of the specimen are given in Fig. 2. Care was taken to provide as large a bearing surface as possible on the face of each of the collars shown in Fig. 2, to avoid distortion under load. At the same time the diameter of the parallel portions between the gauge length and the collars had to be of such a dimension that permanent extension would not take place. The specimen was secured in position at each end by means of locking plates, each locking plate being drilled and slotted as in Fig. 3.



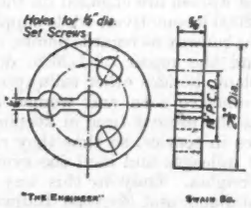


FIG. 2—*The Specimen*
FIG. 3—*Locking Plate for the Specimen*

To fasten the specimen in the machine, the ½in. diameter portion was passed through the slot in each locking plate in turn, the locking plates being then pushed up against their respective collars. One end of the specimen was inserted in a hole in the top of the 7 lb. tup, the depth of the hole being such that when the specimen was pushed home the surface of the collar was $^1/_{16}$in. above the surface of the tup. The set screws used to hold the locking plates in position were prevented from working loose by means of spring washers. A similar procedure was carried out to fasten the other end of the specimen to the arresting crosshead. Fig. 4 shows the specimen attached to the tup and to the arresting crosshead. The method of securing and the specimen itself gave complete satisfaction throughout the tests described in this paper. The specimen was adaptable for use in either the alternating stress fatigue

* The Iron and Steel Institute—July—Abstract.

TABLE I.—*Analyses and Tensile Properties of the Steels Investigated*

Reference letter	A.	B.	C.	D.	E.	F.	G.	H.	I.	J.
Carbon, per cent.	0·12	0·18	0·28	0·29	0·33	0·37	0·47	0·52	0·58	0·63
Silicon, per cent.	0·037	0·066	0·066	0·177	0·066	0·093	0·13	0·103	0·137	0·168
Sulphur, per cent.	0·03	0·04	0·035	0·03	0·035	0·033	0·031	0·042	0·028	0·035
Phosphorus, per cent.	0·02	0·04	0·037	0·011	0·032	0·024	0·045	0·032	0·029	0·032
Manganese, per cent.	0·56	0·56	0·78	0·62	0·66	0·65	0·6	0·72	0·63	0·53
Yield stress, tons per sq. in.	17·0	17·5	20·5	19·6	19·9	21·4	21·8	23·9	26·2	—
Ultimate stress, tons per sq. in.	24·2	26·9	33·4	34·8	34·2	38·3	41·2	44·4	50·7	52·3
Elongation on 4in. length, per cent.	35·0	35·0	25·5	25	27·3	24·3	23·5	20·8	16·3	13·3
Reduction of area, per cent.	66·8	62·6	55·9	53·2	56·3	50·5	47·1	43·0	33·3	28
Brinell number	116	121	153	158	156	163	179	202	207	228

TABLE II.—*0·12 Per Cent. Carbon Steel*

Test No.	Height fallen, in.	Residual height as read, in.	Energy per shock, in.-lb.	Number of shocks.	Total energy for rupture, in.-lb.	Extension on ½in. length, in.	Initial diameter, in.	Final diameter, in.	Reduction of area, per cent.
1	81	5·5	534	1	534	0·2515	0·2505	0·142	67·8
2	78	0·5	548	1	548	0·25	0·25	0·141	68·2
3	78	3	530	1	530	0·244	0·25	0·142	67·7
4	78	1	544	1	544	0·235	0·25	0·142	67·7
5	78	2·5	534	1	534	0·236	0·25	0·142	67·7
6	66·5	53	466	1·2	559	0·251	0·25	0·14	68·6
7	54	31	378	1·44	546	0·234	0·251	0·14	68·9
8	42	37	294	2·14	627	0·274	0·25	0·14	68·6
9	30	4·3	210	2·89	608	0·278	0·25	0·142	67·7
10	19	14	132	6·29	698	0·279	0·2505	0·141	68·3
11	10	1·5	70	12·9	904	0·316	0·251	0·135	71
12	6	3	42	27·5	1,155	0·345	0·25	0·132	73
13	3	—	21	94	1,975	0·362	0·2505	0·124	76·1
14	2	—	14	147	2,058	0·34	0·25	0·129	73·3
15	0·87	—	6·09	579	4,026	0·385	0·25	0·124	75·2
16	0·72	—	5·04	10,002	50,410	0·385	0·2505	0·125	75·2
17	0·61	—	4·27	2,169	9,242	0·305	0·25	0·132	71·9

TABLE III.—*0·18 Per Cent. Carbon Steel*

1	78	3·5	528	1	528	0·24	0·2505	0·142	67·9
2	78	3·25	529	1	529	0·23	0·2505	0·145	66·5
3	78	3	530	1	530	0·234	0·2505	0·144	66·9
4	48	18	336	1·64	551	0·231	0·2495	0·146	66·6
5	29	27	203	3·07	624	0·251	0·2505	0·149	64·6
6	20	9	14	4·58	641	0·276	0·25	0·141	68·2
7	14	6	98	7·61	745	0·278	0·2505	0·14	68·7
8	9	1	63	13·94	878	0·296	0·251	0·14	68·9
9	6	0·5	42	24	1,008	0·297	0·2505	0·142	67·9
10	4	3·5	28	32·2	901	0·317	0·251	0·139	79·4
11	2	—	14	158	2,212	0·327	0·2505	0·13	72·9
12	0·87	—	6·09	1,037	6,515	0·299	0·25	0·132	72
13	0·78	—	5·46	3,203	17,488	0·34	0·2505	0·133	71·8
14	0·72	—	5·04	4,593	23,049	0·288	0·25	0·135	70·6
15	0·675	—	4·72	15,583	73,708	0·15	0·25	0·225	18·9
16	0·61	—	4·27	37,167	158,703	0·233	0·25	0·17	53·9

TABLE IV.—*0·28 Per Cent. Carbon Steel*

1	90	4	607	1	607	0·187	0·2505	0·17	55·6
2	90	4·75	602	1	602	0·185	0·26	0·172	54
3	90	6·5	585	1	585	0·182	0·25	0·172	53·8
4	48	8·75	336	1·83	615	0·19	0·25	0·176	51·9
5	29	11	203	3·65	740	0·201	0·25	0·172	50·4
6	20	1·6	140	5·95	833	0·213	0·25	0·168	51·9
7	14	6·75	98	10·55	1,030	0·214	0·2505	0·165	54·9
8	9	0·5	63	23·93	1,506	0·237	0·2505	0·162	56·7
9	6	2	42	35·75	1,502	0·226	0·2505	0·162	58·2
10	4	2·5	28	95	2,660	0·237	0·2505	0·161	58·8
11	2	—	14	1,287	18,020	0·205	0·2505	0·181	47·8

TABLE V.—*0·29 Per Cent. Carbon Steel*

1	78	0·25	546	1	546	0·21	0·251	0·173	52·4
2	78	0·5	546	1	546	0·186	0·2505	0·175	52·6
3	78	0·625	546	1	546	0·196	0·2505	0·175	51·2
4	48	5·5	336	2·88	968	0·2	0·25	0·173	51
5	29	12·25	203	3·6	730	0·214	0·2505	0·168	52·2
6	20	2·25	140	4·91	688	0·227	0·2505	0·164	55·1
7	14	2·5	98	8·86	868	0·226	0·25	0·162	57
8	9	0·6	63	21	1,328	0·241	0·2495	0·167	57·3
9	6	2·5	42	26·66	1,120	0·235	0·249	0·166	55
10	4	3·5	28	76·25	2,135	0·272	0·2505	0·166	56·1
11	2	—	14	597	8,360	0·253	0·2505	0·168	55·8

TABLE VI.—*0·33 Per Cent. Carbon Steel*

1	84	2	579	1	579	0·202	0·251	0·164	56·2
2	84	3·6	568	1	568	0·2	0·25	0·167	55·4
3	84	2·5	576	1	576	0·21	0·2505	0·162	58·2
4	48	0·75	336	1·99	669	0·226	0·2505	0·166	56·1
5	29	0·25	203	3	609	0·211	0·25	0·165	56·5
6	20	9·25	140	5·56	779	0·235	0·25	0·163	57·4
7	14	0·6	98	9	882	0·234	0·2505	0·163	57·9
8	9	0·7	63	19	1,196	0·246	0·251	0·159	59·9
9	6	3	42	30·6	1,327	0·261	0·2505	0·154	62·2
10	4	1·25	28	65·9	1,946	0·284	0·2505	0·153	62·7
11	2	—	14	764	10,700	0·264	0·25	0·162	57·9

TABLE VII.—0·37 *Per Cent. Carbon Steel*

Test No.	Height fallen, in.	Residual height as read, in.	Energy per shock, in.-lb.	Number of shocks.	Total energy for rupture, in.-lb.	Extension on ½in. length, in.	Initial diameter, in.	Final diameter, in.	Reduction of area, per cent.
1	84	4·5	562	1	562	0·179	0·2505	0·175	51·2
2	84	5·5	555	1	555	0·176	0·2505	0·175	51·2
3	84	5·75	553	1	553	0·175	0·25	0·174	52·5
4	48	7·75	336	1·85	682	0·19	0·2505	0·176	50·6
5	29	14	203	3·54	718	0·191	0·2505	0·177	50·0
6	20	19	140	5·08	711	0·183	0·25	0·175	51·1
7	14	0·5	98	11	1,078	0·224	0·25	0·17	53·8
8	9	3	63	24·7	1,556	0·228	0·2505	0·17	54·0
9	6	1·5	42	36·8	1,545	0·23	0·2505	0·169	54·5
10	4	4	28	193	5,405	0·254	0·251	0·171	53·7
11	2	—	14	1,398	19,580	0·177	0·2505	0·196	38·9

TABLE VIII.—0·47 *Per Cent. Carbon Steel*

1	84	4·75	560	1	560	0·17	0·2505	0·18	48·4
2	84	2·5	576	1	576	0·163	0·2505	0·179	48·9
3	84	3·5	569	1	569	0·166	0·2505	0·178	49·5
4	48	4	336	1·93	648	0·183	0·2505	0·183	46·7
5	29	6·5	203	3·79	770	0·191	0·25	0·171	49·8
6	20	1·3	140	5·96	836	0·184	0·25	0·175	51
7	14	3	98	10·83	1,061	0·184	0·2495	0·18	47·9
8	9	0·5	63	28	1,765	0·211	0·2495	0·179	48·6
9	6	1	42	41·9	1,718	0·21	0·25	0·175	51
10	4	0·5	28	156	4,370	0·222	0·25	0·178	49·3
11	2	—	14	1,869	26,180	0·138	0·2505	0·207	31·85

TABLE IX.—0·52 *Per Cent. Carbon Steel*

1	90	12·5	548	1	548	0·155	0·25	0·186	44·6
2	90	9·75	567	1	567	0·156	0·2505	0·185	45·5
3	90	9·25	569	1	569	0·156	0·25	0·182	47·1
4	48	4·2	336	1·92	646	0·17	0·25	0·186	44·6
5	29	14	203	3·54	718	0·165	0·25	0·187	44
6	20	4·5	140	6·8	953	0·178	0·25	0·183	46·8
7	14	0·25	98	14	1,372	0·186	0·25	0·183	46·8
8	9	3	63	30·7	1,936	0·189	0·25	0·181	46·8
9	6	2·25	42	59·7	2,501	0·201	0·25	0·18	47·5
10	4	0·5	28	239	6,597	0·214	0·2505	0·192	41·3
11	2	—	14	3,131	43,880	0·065	0·2505	0·227	17·85

TABLE X.—0·58 *Per Cent. Carbon Steel*

1	84	7·75	539	1	539	0·121	0·2505	0·2	21·3
2	84	10·75	518	1	518	0·121	0·2505	0·2	21·3
3	84	12	509	1	509	0·116	0·2505	0·201	21·3
4	48	11	336	1·79	602	0·134	0·2505	0·203	16·04
5	29	11·5	203	3·63	737	0·119	0·2505	0·202	12·45
6	20	1·25	140	6·97	975	0·13	0·25	0·201	10·35
7	14	0·5	98	17	1,665	0·145	0·25	0·201	8·66
8	9	3·5	63	46·7	2,940	0·13	0·25	0·208	6·94
9	6	2·5	42	96·7	4,060	0·123	0·25	0·208	5·68
10	4	—	28	879	24,600	0·067	0·2505	0·228	4·63
11	2	—	14	3,074	43,080	0·022	0·2507	0·242	3·26

TABLE XI.—0·63 *Per Cent. Carbon Steel*

1	84	10·5	520	1	520	0·122	0·2505	0·202	35·5
2	78	6	509	1	509	0·111	0·2505	0·206	32·6
3	78	4·25	522	1	522	0·113	0·2505	0·204	33·8
4	48	10·4	336	1·79	601	0·118	0·25	0·206	32
5	30	14	210	3·55	745	0·134	0·251	0·202	35·4
6	18·8	5	132	7·77	1,025	0·136	0·2505	0·203	34·4
7	12	0·25	84	18	1,511	0·135	0·2505	0·208	31·1
8	10	1·75	70	30·9	2,162	0·123	0·251	0·210	29·7
9	8	3	56	50	2,800	0·135	0·25	0·212	25·9
10	6	1	42	183	7,690	0·115	0·2505	0·217	24·9
11	3	—	21	1,438	29,500	0·146	0·25	0·24	7·4
12	2	—	14	3,621	50,694	0·025	0·2505	0·242	6·4

TABLE XII.—*Average Single-Shock and Corresponding Static Test Results*

Reference letter	A.	B.	C.	D.	E.	F.	G.	H.	I.	J.
Carbon content, per cent.	0·12	0·18	0·28	0·29	0·33	0·37	0·47	0·52	0·58	0·63
Average single-shock energy, in.-lb.	538	529	598	546	574	557	568	561	522	517
Static energy, in.-lb.	550	616	708	674	663	723	672	688	571	550
Ratio of single-shock energy to static energy	0·97	0·865	0·854	0·808	0·862	0·77	0·845	0·84	0·91	0·94
Average single-shock extension, in.	0·243	0·235	0·182	0·197	0·203	0·176	0·167	0·155	0·121	0·113
Static extension, in.	0·26	0·249	0·197	0·205	0·21	0·19	0·164	0·159	0·115	0·115
Average single-shock reduction of area, per cent.	67·7	67·1	53·2	52·5	56·6	51·2	49·0	45·1	36·3	33·7
Static reduction of area, per cent.	68·2	67·8	54·2	55·6	54·7	51·1	47·1	44·0	32·6	34·0

testing machine or the static tensile testing machine.

THE MEASUREMENT OF RESIDUAL ENERGY

When a specimen is fractured in an impact machine, only part of the energy imparted to the pendulum or tup is used to rupture the test piece. The remaining energy is called the residual energy.

The tup, after fracture of the specimen, fell into a socket in one end of a simple lever at rest. The lever was balanced with the tup in the socket, and, on receiving the falling tup, proceeded to rotate about the centre of gravity of the lever and tup, in a vertical plane. This rotation was opposed by a helical spring, the energy of rotation of the lever and tup being converted into strain energy of the spring. Now, in an arrangement of this nature, the kinetic energy of rotation of the lever on receiving the falling tup is a definite fraction of the kinetic energy of the tup just before entering the socket, assuming that the tup does not rebound from the socket, but moves as one with the lever. This is provided for by using a taper socket and spring clips which hold the tup firmly in position.

THE TUP

Examination of the results obtained by Smith and Warnock[1] showed that the energy required to rupture a ½in. diameter specimen of Lowmoor iron was approximately 400 inch-pounds. The maximum height at which the machine could be operated was approximately 100in. for single-shock tests. It was estimated that a 7 lb. tup, representing a maximum available amount of energy of 700 inch-pounds, would permit the machine to be used to the best advantage. Inspection of the results obtained (Tables II to XII) shows that the maximum single-shock energy for the steels tested was 600 inch-pounds.

The tup was turned from a length of 2¾in. mild steel bar. It was necessary for the purposes

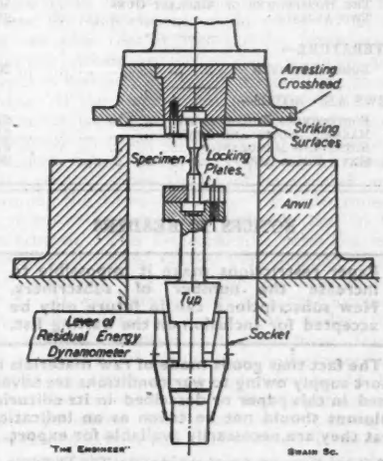


FIG. 4.—*Section through the Arresting Crosshead and Anvil, showing the Specimen and Tup in Position*

of balancing that, when in position in the socket of the lever, the centre of gravity of the tup should coincide with the longitudinal centre line of the lever. This, together with other factors, resulted in the form of tup shown in Fig. 4. The weight of the tup, together with a half specimen, a locking plate, three set screws, and three spring washers, was 7 lb.

MATERIAL USED IN THE INVESTIGATION

The material used in the tests recorded in this paper consisted of a family of steels of varying carbon content, the other constituents being approximately constant. The ten steels of the family were manufactured by the Steel Company of Scotland, Ltd., and supplied some years previously for stress endurance tests. The steels were supplied in the form of 1in. diameter bars from which the specimens were machined. The material did not receive any heat treatment after manufacture.

The chemical analyses of the steels as supplied by the manufacturers, together with the results of tensile tests, are given in Table I. The tensile tests were carried out on a Riehlé screw-testing machine, the specimens being 0·625in. in diameter, with enlarged ends.

The Brinell hardness tests were carried out, using a 10 mm. ball and a load of 3000 kilos. for 15 seconds, on short lengths cut from the bars. Two indents were made in the direction of the axis of the bar, and the average value was taken in each case.

(To be continued)

[1] Smith and Warnock, *Journal* of the Iron and Steel Institute, 1927, No. II, page 323.

The Engineer

SEPTEMBER 10, 1943

VOL. CLXXVI No. 4574

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THIS FREEDOM

SOME years ago Sir Ernest Benn was the moving spirit in the "Individualist Bookshop," which published pamphlets—many by Sir Ernest himself—in defence of the liberty of the individual. It made its mark, but in a relatively small way. No one felt then that his freedom was seriously endangered, and most people tolerated restrictions on the ground that the conditions were so changed from what they had known in their youth that regulations had become necessary and desirable. Then came the present war, bringing with it the almost complete destruction of individual liberty. Again the people accepted their fate. They believed that in no other way could the country be mobilised for total war. But whilst they bore with only faint grumblings the curbs upon their ancient liberties, many of them soon began to show that, although they might endure the shackles of bureaucracy whilst the war lasted, they would fight tooth and nail to break them when peace returned. Then the "Individualist Bookshop" found that it needed more scope, and a few months ago it became the "Society of Individualists." Its progress since then indicates very clearly and positively the extent of the reaction against bureaucracy and the growing determination to be rid of it as soon as possible when the war is won.

The matter is one in which all branches of the engineering industries are deeply involved. There is no human vocation which owes more to individual enterprise than engineering. It would be easy to give a score of names of firms which have been brought to greatness, and have conferred inestimable benefits on mankind, solely through the courage and persistency of single men. Indeed, it might be said with a great deal of truth that the history of engineering is the history of individuals. It is not necessary to inquire by what motives they were inspired. In some it was the quest of power, in some the lust of gain, and in others the mere joy of achievement. The result was the same. By their works they benefited mankind, and it matters little or nothing whether or not they benefited themselves. They relied on themselves, they asked little from the State, and resented rather than courted its assistance. Self-dependent, they were prepared to face obstacles and difficulties and to ask no one else to bear the blame if they failed. Some people profess to see only the defects of this "sturdy independence," but a vast majority of the inhabitants of this land admire in their hearts of hearts personal valour and achievement. Each of them may want to see someone else controlled by an external and impersonal power, yet each of them cherishes as his birthright his own individual liberty. For the moment, we all must tolerate restrictions; for the moment we must allow the Executive to usurp the functions of the Legislature, but the time will come, soon after the war, when there will be a reaction against bureaucratic control, and in that reaction we shall see engineers in the vanguard.

The growing influence of the Society of Individualists is as a vane showing the direction in which the wind is beginning to blow. Amongst its most recent publications is one that, both by its restraint and understanding, is worthy of particular attention. The author is the Professor of Modern History in the University of Leeds, Mr. A. S. Turberville. It is entitled "Quantity *versus* Quality," which in this connection means collectivism against individualism. We are tempted to make quotations from it in support of what we have said, but know not where to begin or where to end. We must, then, restrict ourselves to two, whilst commending the pamphlet to all engineers who await the restoration of their liberties. The first quotation runs thus: "The individualist desires to see the ideal of the balanced constitution reinstated in place of the conception of the omni-competent Executive. He desires to see a reawakened realisation of the fact that it is the force of human personality that gives meaning and beauty and strength to the life of man; a keener appreciation of the perennial value of the austerer virtues, and especially of independence and self-reliance. He is never insensible of the needs of the people." The second: "It is quite certain that individualism cannot and will not remain under a cloud indefinitely. There are two reasons for this optimism, each sufficient in itself. The first is that all true progress is the result of the creative capacity of the mind of man, and that capacity, unable to work effectively if it is 'cabin'd, cribb'd, confin'd,' will eventually break out from the restraints imposed upon it. The second is that human nature is, in the long run, on the side of the individualist."

Idle Moments

DR. WATTS was doubtless sincere when he claimed that "Satan finds some mischief still for idle hands to do," but whether it is strictly true that idleness inevitably results in mischief is open to question. Admittedly, while the day appears too full for some, others complain of a lack of occupation, and though it may be "a consummation devoutly to be wished," we are never likely to arrive at that happy state of perfect balance where every member of the community pulls his or her weight, with no one overloaded, no one idle, but we should hesitate from looking upon the latter class as a menace to society. May we consider what we mean by being idle and what can be done to cope with the situation? The dictionary suggests a variety of lines of thought, and if we accept the meaning of "laziness" or "indolence," we are certainly confronted with a state that can be wholeheartedly condemned, while if the inference is a "lack of purpose," we may not feel so frustrated, but can set to work to attempt to produce a change of outlook, and similarly the "useless" can be converted to the "useful." At the moment, however, the interpretation we have in mind is that of being "unoccupied," and our purpose is to explore this condition. It is quite conceivable for a temporarily idle person to subscribe to the old adage *labor ipse voluptas*, and yet, however much he may love work, to attain a state of contentment he must also know how to revel in enforced idleness.

Idleness may occur from a variety of causes; it may occur at the most unexpected times: a managing director might have a number of appointments, one of which suddenly broke down at the last moment giving him half an hour which he did not expect to have at his disposal. We wonder what his reaction would be. Would it be too revolutionary to suggest that he should resist the temptation to substitute another appointment, but welcome the break as a heaven-sent opportunity for a short period of reflection, of mental stocktaking, which might prove invaluable? It is, perhaps, when we descend to the lower grades that the problem becomes rather more acute, for it is suggested that the assistant engineer, technical assistant, or whatever he may be designated is likely to encounter periods of heavy pressure, and others of relative stagnation. It is in the second state that his worth can best be determined and his character formed. Each junior must at times reach a point at which he has

to consult his chief on some point of policy or to seek definite instructions. If he cannot be seen immediately, does he return to his drawing board or desk and twiddle his thumbs, or does he employ the time in cogitation as to what improvements he can effect in his work, what modifications he could suggest in a design? If he does, then surely the time of forced inaction can by no stretch of the imagination be called idle time. The junior may be allowed considerable latitude in his duties, and given certain work for which he is directly responsible; but, however well he organises his days, there will be seasons when everything seems to go quiet, and perhaps his first reaction is to approach his chief with the complaint that he has not enough to do. Perhaps it might here be stated as an axiom for the young engineer that the work of an assistant is largely what he himself makes it. Many a young man has qualified for promotion, not so much because of the faithful manner in which he has carried out the tasks assigned to him, but rather because he has anticipated the wishes of his chief, and has carved out for himself by his own assiduity a niche in the organisation which no one else could fill, thereby giving him eventually a recognised position. Much of this has resulted from the judicious utilisation of what would otherwise have been unproductive periods. Descending the scale of industry, it will readily be realised that a mechanic often has idleness thrust on him by something entirely outside his control. A turner's lathe breaks down, but can soon be put right, so that there would be no question of a transfer elsewhere; does he spend his time sprucing up his lathe, making those minor adjustments which he has been intending to do for some time, and putting things generally in order or does he pass the precious moments in gossip? One further instance of what is in mind must suffice: in a period of industrial depression a large engineering works had hardly an order on its books, plant lay idle, but the office appeared exceptionally busy, for new designs were being prepared, more up-to-date plant was actually being ordered and installed, and the premises were being extended by a board of directors, who realised that a spell of idleness could best be utilised by preparing for a term of prosperity. Their vision was justified, and the firm reaped the benefit afterwards, so that it is suggested that behind this incident lies a very important moral.

Perhaps enough has been said to show that there is no need for idle moments for the engineer, and also that one who outwardly looked extremely lazy might really be engaged on truly constructive work! Recently publicity was given in the daily Press to an allegation that certain Government engineers were not fully occupied. Without going into the merits of the case, we would at least suggest that a visit by a reporter to many an engineer's office might result in an entirely erroneous impression. No one would expect the number of doctors in a district to be reduced because of a period of immunity from epidemics, although we might reasonably surmise that the spare time would be profitably used by a conscientious practitioner in attempting to keep abreast of the times by study and research. Similarly, there need never be any idle moments for the zealous engineer.

Letters to the Editor

(We do not hold ourselves responsible for the opinions of our correspondents)

THE HORSEPOWER OF AIRCRAFT GUNS

SIR,—Your leading article in THE ENGINEER of August 27th gives further prominence to a method already coming into use of comparing the performances of machine guns by their horsepower.

There is, however, a misleading suggestion in the question "What happens when a 2000 H.P. engine pulls an aircraft forward and 2500 H.P. of gun power pushes it back?" It is true that the momentum, the integral of force × time, imparted to gun and projectile, is equal and opposite. Energy, however, is the integral of force × distance, which is very different for the gun and projectile. Ignoring for the moment the recoil arrangements and also the mass of the gases, let us say that the mass of the gun barrel is fifty times that of the bullet, then the distance travelled by the gun in free recoil would be 1/50th of that travelled by the bullet. Since the force exerted on each at any instant must be the same, the energy imparted to the bullet and gun will also be in the ratio 50/1. Hence the damaging effect of the bullet due to its kinetic energy (apart from any explosive it may contain). It would be a poor design of gun in which the barrel had as much energy to expend on the user as the bullet has for the enemy!

CHAS. H. HELMER.

Royal Naval College,
Greenwich, S.E.10,
August 31st.

[We agree that if the gun power were really used to propel the aircraft instead of to destroy the enemy, momentum rather than kinetic energy would be the main consideration, and the measure of horsepower would then depend on the air speed attained.—ED., THE E.]

TWO APPEALS

SIR,—In your issue of August 27th you referred in gracious terms to the book we have issued at long last after the several war years, and I venture to ask your assistance, as representing all that is best in mechanical contrivances, by printing this letter in respect to the efforts of those who have gone before us.

It is known from documentary evidence in our possession that George Gwynne in 1844 took an order from, and supplied to, the Passaic Copper Mine in U.S.A., a centrifugal pump "twelve feet in diameter." Your paper must circulate among engineers in America. Can anyone throw any light on this pump? George Gwynne in September, 1851, stated that it was the first double-entry centrifugal pump. It would be of wide interest if a description could be dug out of the past.

My second point deals with a matter at home. Lade Bank land drainage pumps were supplied and put to work in 1867 by Easton, Amos and Anderson. These were the first centrifugal pumps installed for land drainage in the Fens. They worked until 1938, and on more than one occasion I have pressed for their retention as museum pieces equivalent to George Stephenson's "Rocket." Mr. Buchner, the engineer to the district, has told me that his Commissioners have just given orders for the breaking up of these two pumping sets. They are a magnificent example of the ironfounder's art, and while their value as superb examples of engineering work in 1867 cannot be assessed in cash, their value as scrap will be trifling when cost of dismantlement and transport is considered. Cannot at least one of the two sets be preserved?

For GWYNNES PUMPS, Ltd.,
W. A. TRITTON, Director.

Lincoln, September 1st.

Sixty Years Ago

SHIPBUILDERS AND THE BOARD OF TRADE

SIXTY years ago Joseph Chamberlain was President of the Board of Trade. So far as its Marine Department was concerned, he was determined upon reforming it. If all that we said in a leading article in our issue of September 14th, 1883, was true, the time for reformation was over-ripe. As it existed, the Department, we said, was a fossil, interesting but useless, if not in the way. Its great want was intelligence, its great defect red tape, and its greatest drawback small salaries. As an instance of the Department's futility we mentioned its attitude towards the fixation of the load lines of ships. It was legally charged with the duty of taking action against shipowners who broke the Load Line Act. If, however, a shipowner asked the Department to fix a load line for any of his ships, the Department would refuse to do so on the plea that it was not its business to instruct owners on the subject, while in any event it had no rules which would apply to all ships. If the Department had done too little in the matter of load lines, it had, we said, done too much in other directions. It had on one occasion issued an order requiring all closet fittings and pipes to be of gun-metal and banning the use of cast iron. The order roused a storm of protest and eventually had to be withdrawn. The Department's rules for the strength of marine boilers were laughed at by the engineers who were compelled to follow them. It was fortunate, we said, that locomotive superintendents were not under the Department's control. If they were, there would not be a locomotive boiler carrying 130 lb. to 150 lb. pressure, which would be passed for more than 60 lb. The Department's rules governing the granting of passenger certificates to river steamers were also instanced as an example of its incompetence. The number of passengers allowed to be carried was simply the number of square yards of deck space. Provided her boilers and safety valves complied with certain conditions, she was considered safe to carry the number of passengers so determined, although her bottom might be no thicker than brown paper, she might have no bulkheads, and her whole structure might be so weak that a touch by a barge would send her to the bottom. What might happen, the fate of the "Princess Alice" told us.

BOOKS RECEIVED

British Locomotive Types. London: Railway Publishing Company, Ltd., 33, Tothill Street, S.W.1. Price 8s. net.

Applied Mechanics. By A. Morley. London: Longmans, Green and Co., Ltd., 43, Albert Drive, S.W.19. Price 7s. 6d. net.

Oil and Petroleum Year Book, 1943. Edited by Walter E. Skinner. London: W. E. Skinner, 20, Copthall Avenue, E.C.2. Price 12s. 6d. net.

Regional Planning. By L. B. Escritt. London: George Allen and Unwin, Ltd., Ruskin House, Museum Street, W.C.1. Price 12s. 6d. net.

Elementary Structural Analysis and Design. By L. E. Grinter. London: Macmillan and Co., Ltd., St. Martin's Street, W.C.2. Price 18s. net.

Elementary Handbook of Aircraft Engines. By A. W. Judge. London: Chapman and Hall, 11, Henrietta Street, W.C.2. Price 12s. 6d. net.

Illinois State Water Survey: Bulletin No. 21, Supplement 2, Bulletins Nos. 32 and 34. U.S.A.: State Water Survey Division, Urbana, Illinois.

Post-War Planning for the Electricity Supply Industry. London: Electrical Power Engineers' Association, 102, St. George's Square, S.W.1. Price 1s. net.

Dry Docks for United States Navy

No. III—(*Continued from page 184, September 3rd*)

WHILE the tremie method of constructing dry docks has made it possible to save much time and to complete the largest of this type of graving dock in about two years—similar docks having in the past taken much longer—nevertheless, Rear-Admiral Harris has pointed out that his tremie method calls for large preliminary outlays in plant and in planning the work, and therefore the final value of tremie-placed concrete in dry-dock building and its use will have to be determined by controlling conditions or by the circumstances to be met. It is pertinent, with this proviso in mind, to describe how the Bureau of Yards and Docks has built in the dry a large offshore graving dock at Long Beach, California. The contrast is instructive.

This west coast graving dock, which has an available length of 1100ft. and a width of 150ft., and with the base level of its concrete floor 60ft. below the mean level of low water, was designed by the Bureau of Yards and Docks. The inner or head end of the dock is virtually tangent to the erstwhile beach line, and the entrance is offshore 1100ft. in the sea area, where the water prior to the construction of the dock had a depth of from 18ft. to 20ft. The primary protection of the dock from the open sea consists of a breakwater that lies 2½ miles offshore.

From the underside of the concrete floor of the dock upward, the ground is a formation of sand, silty loam, and clay streaks. Below the dock floor, to a depth of from 50ft. to 60ft., is a bed of fine to coarse sand, and beneath that sand, for a depth of from 15ft. to 20ft., is a layer of silty loam and clay streaks. Beneath this layer follows a bed of coarse water-bearing sand and gravel that extends downward for a considerable depth. The projected dock area was extensively explored prior to the start of any construction work. A test pit was sunk near the dock site, 50ft. or so deep, with the help of well points. Using test pumps and making observations while pumping was under way, ground water levels were ascertained at different locations. The observation wells for this exploratory work were provided by driving pipes to the depths deemed desirable and clearing them of earth by jetting. The various materials thus removed at the dock site were subjected to laboratory analysis, and, combined with the pumping data, information was obtained upon which to base calculations for pumping dry the contemplated excavation after the area would be surrounded by a dyke. The actual amount of water that had to be pumped to clear the excavation varied from 25,000 to 36,000 gallons a minute. The advance estimates approximated those figures closely.

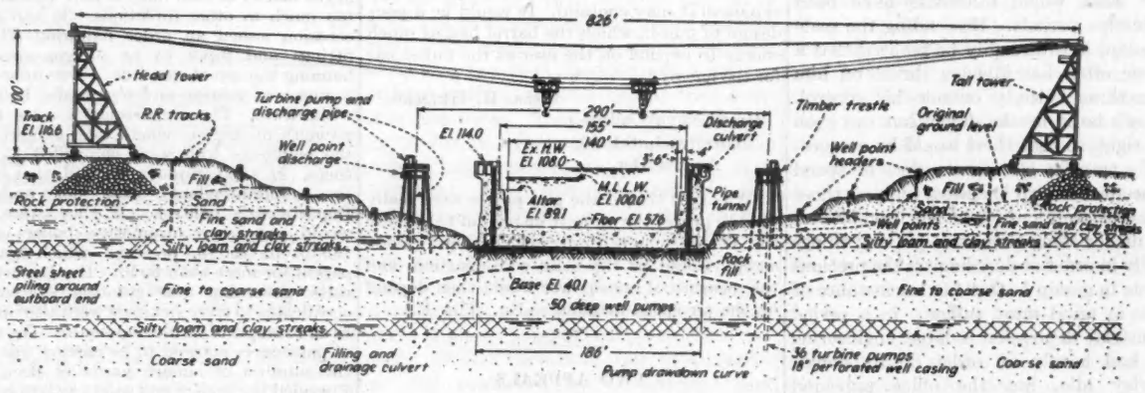
The basin was excavated down to El.—60 by a floating hydraulic dredger, and while that work was in hand, a sea wall of rock was reared around the dock site, leaving an opening at the seaward end through which the dredger and other floating equipment could be withdrawn when no longer required. When the dredging was done the remainder of that floating plant was employed in the building of a timbered trestle that surrounded the entire dock area, and from the deck of that structure a total of thirty-six gravel-packed deep wells was sunk by rotary well-drilling outfits. Each well had a diameter of 30in., and those wells, which lay outside the dock limits and were spaced at various intervals, penetrated the ground deep enough to reach the layer of silty loam and clay streaks—that is, at El. — 120ft. or more. Some of the wells stopped a little short of the clay layer, while other of the wells passed through that layer and entered the underlying bed of coarse sand. The object in going through the clay stratum, which was thought to be more or less impervious, was to neutralise any possible hydrostatic uplift. This precaution was taken even though the engineering calculations indicated that the weight of material lying above was ample to offset any upward hydrostatic pressure. Each deep well was equipped with a 2000 gallon-per-minute pump and submersible motor, and the discharge from the pumps was piped up through a check valve from a header on the outer side at the top of the trestle, and the header discharged the water overboard well beyond the immediate surroundings of the workings.

On the trestle there were two turbine pumps, each of 6000 gallons per minute capacity, that removed sea water from the expansive pool which was enveloped by the rock dyke. Those pumps unwatered the excavated dock basin in the course of six weeks, and when the water level was lowered a few feet pumping was either slowed or halted to allow time for the surrounding banks to drain themselves. Incidentally, the deep wells influenced the pool level by removing percolating water. The water from the wells was tested at intervals for salinity, and usually carried a salt content about one-third that of the outlying sea water, but, even after complete unwatering of the excavation for the dry dock was effected, still the water pumped from the deep wells was somewhat saline.

The maximum rate of pumping from the wells was maintained for about five weeks, and then dropped to 28,000 gallons per minute. By that time the observation wells along the longitudinal centre line of the dock site indicated that the ground water had been lowered from 10ft. to 20ft. below the bottom of the excavation, which was at a level 60ft. below mean low water. There were other observation wells for the study of ground-water conditions, and those wells were spaced along a 4000ft. line that extended westward of the dock site. When approximately two-thirds of the concrete bottom slab of the dock had been placed, the pumping rate dropped to something like 26,000 gallons per minute, which indicated that the installed pumps had quite doubled the capacity which pumping experience had shown to be necessary.

In addition to the foregoing deep well pumps and the two large pumps carried on the trestle, a total of 1600 well points, with 24ft. risers generally and arranged on 4ft. centres, were utilised to stabilise the banks of the excavated area lying outside the trestle. The well points were arranged in three parallel lines at different distances from the trestle, and they had a maximum united discharge of about 2000 gallons per minute. As a matter of fact, the various well points were located where there was reason to believe they would give their greatest yields.

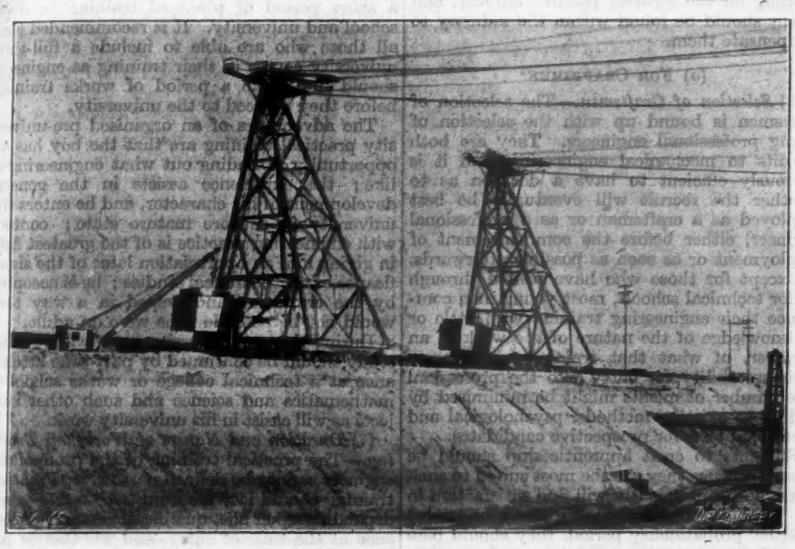
All floating equipment within the dock area was removed when the trestle had been built, but before the floating plant was taken away some of it was used to place hydraulic fill along the sides of the rock sea wall. A fleet of motor lorries, loaded by drag lines with sand dredged from borrow areas, helped in transforming the rock wall into a dyke enclosing the entire site, except at the ocean end of the dock. At that point fill was deposited only on the inner slope of the rock breakwater, while the outer side, exposed to the wash of the sea, was not so covered, because it would have been useless. However, as an added safeguard, a steel sheet pile cut-off wall was driven just inside and paralleling the rock wall at that point. The 60ft. piles were driven across the length of that exposed section of the enclosure and for a suitable distance along the adjoining sides of the dyke. The cut-off wall was tied to the rock sea wall by steel rods, and the supplemental barrier wellnigh shut off all inward seeping of sea water. It was after this work



ARRANGEMENT OF PLANT FOR CONSTRUCTION OF DOCK

was completed that unwatering of the enclosed area was started.

As originally planned, the Long Beach graving dock was to be constructed by tremie-poured concrete, and the forms for that concrete were to be lowered on to the submerged bottom of the excavation. The steel work of the forms also was to provide reinforcement for the concrete of each transverse block of the floor slab. Agreeably to that plan, and at an early stage of preparation, cableways were ordered to be used in handling the tremie forms contemplated. Subsequently, the Bureau of Yards and Docks decided to unwater the impounded area so that the work could be done in the dry, and the cableways were installed and used in placing the concrete with 8-yard bottom dump buckets. Running on a wide gauge track, paralleling the dock area on each long side, were mounted two travelling towers, each 100ft. high above the track elevation. The towers were placed 826ft. apart, one of each pair of towers acting as a head tower while the other functioned as a tail tower. Each cableway system for a pair of towers carried two travellers that permitted a shorter interval between the dumping of successive buckets. Also the tremie forms originally provided were cut into smaller sections—two to a form side—which made them easier to handle and to place by means of the cableways.



CABLEWAY TOWERS

The concrete was supplied by a central mixing plant equipped with two 4-cubic yard mixers and otherwise provided with up-to-date batchers and the means of turning out uniformly a large volume of concrete in close agreement with the specifications. The mixers delivered directly into the 8-yard dump buckets, three in number, carried on each flat car. The cars were successively spotted at the loading position by a locomotive and then hauled to the cableways at the dock side.

Immediately following the unwatering of the dock excavation the exposed bottom was covered to gradient with an 18in. blanket of broken stone and levelled. The forms for the transverse sections of the floor were placed upon that bed, the forms being required only for alternate sections, each of which, when filled with concrete, was a block 18ft. square in cross section and 180ft. long. The space between each pair of adjacent blocks was poured without a form, and the opposed vertical surfaces of the flanking blocks were slightly concave, so as to act as a keyway for the later placed concrete. The intermediate block was strengthened and further tied to the two bounding blocks by reinforcing steel that was arranged before the concrete for such blocks was poured. Each transverse block of the floor slab contained about 2300 cubic yards of concrete.

In the course of forty-eight calendar days, following the complete unwatering of the dock excavation, the contractors poured the forty-sixth floor block, and as some parts of the side wall sections were poured shortly after the concrete was placed for the different floor blocks, at the end of the period mentioned approximately 100,000 cubic yards of concrete had been poured, something like half of all the concrete needed for the entire dock. Curing water for the concrete surfaces was obtained from the pipe line on the trestle that carried away the discharge from the deep well pumps. This afforded a convenient and an economical supply of water for curing purposes.

The Bureau of Yards and Docks has set an example of further possible economies by the manner in which it has adapted to permanent use a large group of the pumps employed during the unwatering of the dock area at the time of construction. Bids had been asked on large pumps of conventional type to be installed for emptying the dock when required in handling ships, but the tendered prices were high and there were uncertainties about deliveries. The Bureau accordingly sought some better solution of the problem of permanent equipment. After due study the decision was made to adopt smaller turbine pumps, such as the thirty-six units that had given satisfaction during the unwatering operation. All told, only fifty of such pumps would be needed for the purpose, but fourteen more than the units at hand on the job. The arrangement was considered to have several advantages. There would be a decentralised flow of the water being dealt with, opportunity would be offered for servicing individual pump units without interrupting or interfering with the operation of the dock, and the Bureau's experts further concluded that there would be a number of other gains. Accordingly, that plan was adopted for the completed structure. The thirty-six deep well pumps of the original lot and the additional fourteen pumps of similar type and size have been installed, with their submersible motors, in vertical wells provided for them in the concrete walls of the dock. These wells, at their lower ends, connect with a bottom culvert that extends entirely around the dock, and the culvert functions, both as an inlet and an outlet channel, receiving water from the dock through drains and connecting passages in the floor, and it also has gates at its outer ends that provide communication with the sea. With the gates open, sea water flows through the culvert and enters the dock basin by way of the drains in the floor. The incoming water is thus dispersed over a wide area, and this prevents the development of strong currents that might suffice to displace blocking during the filling or flooding operation.

The steel caisson gate for the dock entrance was erected on the dock floor during the construction stage of the dry dock, and was floated when the dock was flooded for the first time, which took place when the dyke at the entrance of the dry dock was removed. Captain E. C. Seibert, Civil Engineer Corps, U.S. Navy, was the officer in charge of construction of the Long Beach graving dock, and that expert has summarised in the following manner the high points of the novel method employed in doing the work: "The dewatering scheme of dry dock construction used in this instance bids fair to establish a new mode of attack, in applicable cases, to graving dock construction. Although the method involved uncertainties, these can be reduced by devising means to assure a tight and stable enclosing dyke and by control of water pressure in deep underlying strata to prevent flow into, and uplift of, the bottom of the excavation. This method can be the means of saving many months in construction time and a very considerable amount of money as compared to the indicated conventional means of placing at least the bottom by tremie. Moreover, building in the dry ensures a better quality of concrete. Before the dewatering method can be safely applied, much advanced information must be obtained. Studies that should be made include geological investigation, borings, pumping, and laboratory tests of samples to determine flow or percolation rates. If it is determined in any given case that the water can be economically pumped out at a rate faster than the percolation or infiltration rate, the use of the method appears feasible."

The contract for the Long Beach graving dock was awarded by the Navy Department to Guy F. Atkinson Company-George Pollock Company on a cost-plus fixed fee basis. For the contractors, Davit Root was general manager, Frank Nicol chief engineer, and Harvey Kruse dry dock superintendent. The Bureau of Yards and Docks, in which this dry dock was designed under the direction of Rear-Admiral Ben Moreell, of the Civil Engineer Corps, Chief of the Bureau, was represented on the job by Captain E. C. Seibert, Lieut. L. W. Painter (C.E.C.) (U.S. Naval Reserve), and Nathan Karp (civil engineer, also in the Navy Office at the scene of operations).

TEAK AS AN INDIAN ASSET.—Recent advances in the technique of raising and maintaining teak plantations are the subject of a publication issued by the Forest Research Institute, Dehra Dun. An eventual shortage of natural teak timber in India has long been considered inevitable. To guard against this deficiency, teak plantations have been raised on a steadily increasing scale. The earliest plantations were started at Nilambar in Madras in 1842, just a century ago, and they have now yielded a return many times their cost of production. Teak plantations have since been established in all provinces, except the Punjab and Sind, and in a large number of states. At present there are well over 200,000 acres of teak plantations all over the country, and over 6000 acres of new plantations are being added every year.

Education of Engineers*

No. II—(*Continued from page 187, September 3rd*)

SECTION VI.—COURSES FOR CRAFTSMEN

(1) *Wider Provision of Courses.*—Much wider provision of craft courses in technical colleges will be necessary to provide for youths at the smaller works having no organised apprentice instruction, and to utilise the day release for youths unsuited to more advanced technical studies.

Properly employed, the day release should be of special benefit to craftsmen.

(2) *Equipment of Workshops.*—The technical college workshop should be the craft apprentice's laboratory. It should be equipped on an adequate scale with a view, not so much to teaching manual skill, as to teaching the principles underlying workshop operations.

(3) *Variety in Training Schemes.*—In craft apprentice training there is ample scope for variety in schemes of education and training, particularly in relation to the arrangements for practical training. This may be given entirely in the works, or partly in the works and partly in the college. If the latter scheme is adopted, the practical training in the college might take the form of a full-time course prior to entering employment or a part-time course concurrent with employment. The system adopted in any particular case will obviously depend on local conditions, in particular on the facilities which firms have for properly organised practical training in their own works.

(4) *Certification on a National Basis.*—There is an urgent need for a certificate scheme operated on a national basis for the theoretical studies of craft students. Craft students are at a serious disadvantage compared with professional students because they have not before them the incentive of a certificate awarded on a national basis and backed by influential bodies. A section of the field is partially catered for by the City and Guilds craft courses and by development a suitable scheme of certification might be erected on this foundation.

(5) *Courses for Foremen and Others.*—The provision of suitable training for foremen and others, production planning, rate-fixing, and inspection has been seriously neglected in the past. Such courses should be arranged to follow craft or National Certificate courses.

SECTION VII.—RELATION BETWEEN TECHNICAL EDUCATION AND PRACTICAL TRAINING

Works training and technical training should be planned as a whole, and closer relations are needed between educational institutions and industry to secure this end. Technical colleges send regular reports to firms on the progress of the part-time day students they teach, but it is doubtful if full use is made of these, and much more co-operation is needed. College representatives should be invited to sit on works training committees, just as representatives of industry sit on college advisory committees, and thus ensure joint interest in the progress of the individual apprentice as well as in general questions of training.

SECTION VIII.—PRACTICAL TRAINING

(1) *Objective.*—The practical training of the apprentice engineer should be directed to enable him to acquire :—

(*a*) Skill in the manipulation of hand and machine tools.

(*b*) That knowledge of materials which can be acquired only by handling and working with them.

(*c*) Knowledge of manufacturing processes and methods, and the limitations they impose on design.

(*d*) Knowledge of workshop organisation, and the control of the flow of materials during manufacture.

(*e*) Knowledge of the personnel with whom, and for whom, he works.

These objectives are amongst those which should be embraced in the modern conception of engineering apprenticeship.

For a long time the term "apprenticeship" has ceased to represent the complete, intimate, and thorough training which it represented in the days of the guilds. The degree of responsibility shown by the employer towards the apprentice varies from almost zero to something which still falls below the highest standard set by the "masters" in the days of the guilds.

Too many cases still exist where "apprenticeship" is exploited as a form of cheap labour, and in recent times a narrowing practice has arisen—which the Institution deprecates—of apprenticing youths to the drawing-office, to rate-fixing, and to other limited sections of engineering work, leading in many cases to dead-end occupations.

During and since the war of 1914–18 there has been an awakening to the need for the more thorough training of both craft and professional engineering recruits. It is desirable that those organisations having the facilities to give the best training to young men should be nurseries for an industry and provide opportunities for training for the greatest possible number, and means should be found within the industry to compensate them.

(*a*) FOR CRAFTSMEN

(2) *Selection of Craftsmen.*—The selection of craftsmen is bound up with the selection of young professional engineers. They are both recruits to mechanical engineering, and it is obviously efficient to have a decision as to whether the recruit will eventually be best employed as a craftsman or as a professional engineer, either before the commencement of employment or as soon as possible afterwards.

Except for those who have passed through junior technical schools, most young men commence their engineering training with little or no knowledge of the nature of the work of an engineer, of what that training involves, or their suitability for entry into the profession. The number of misfits might be minimised by adding to existing methods, psychological and vocational tests for prospective candidates.

Entrants to craft apprenticeship should be chosen because they are the most suited to such work, and consequently will find satisfaction in it. If this is confirmed after a six or twelve months' probationary period, they should pass out of the apprentice workshop and continue to learn their chosen craft in the main workshop and attend corresponding workshop courses at a technical college. Provision should always be made to make possible the transfer of youths who later prove their greater suitability for the alternative course to that in which they have been placed by earlier selection.

(3) *Workshop Training.*—Recruits for craftsmanship should be trained under experienced instructors and not be entirely dependent upon a nearby craftsman or foreman whose preoccupation is with production and not instruction.

Instructors should be selected for their skill, for their ability to impart knowledge and gain the confidence of the young men in their charge, and not because they have passed the stage of full usefulness in workshop management.

Special apprentice workshops, or apprentice bays, should be available for preliminary craft instruction of not less than six, or more than twelve months' duration. Apprentice workshops should produce parts, or even assemblies, for stock.

Small firms may have to depend on the technical college to provide some of the practical training in craftsmanship as well as the whole of the technical training.

Subsequent practical training could be carried out under the normal conditions of the workshops, but with the actual work of the apprentice still guided and directed in such a way as to ensure a complete experience.

(4) *Duration and Scope of Training.*—Under present agreements between employers and trade unions, the length of craft apprenticeship has been fixed at five years. With effective instruction and proper facilities for training, an intelligent youth or man could attain a standard of craftsmanship, at least equal to that of the average craftsman of to-day, in a period of three or four years at most. In the future, the period of apprenticeship should become less rigid, and attainment be a factor in determining its duration.

(5) *Daytime Release.*—Under the White Paper proposals for compulsory part-time education in working hours, the craft apprentice can receive workshop craft instruction as distinct from the higher technical instruction involved in National Certificate courses, together with general education and physical training, at a works school or a technical college directed towards the certification referred to in an earlier section.

(*b*) FOR PROFESSIONAL ENGINEERS

(6) *Pre-University Workshop Training.*—Up to the end of the nineteenth century almost all professional engineers obtained their theoretical training by part-time study concurrent with their apprenticeship course. With the increasing development of university training for engineers, a large number of young men obtained the greater part, if not all, of their practical training after graduation. During the past twenty years a few young men have secured a short period of practical training between school and university. It is recommended that all those who are able to include a full-time university course in their training as engineers should undertake a period of works training before they proceed to the university.

The advantages of an organised pre-university practical training are that the boy has an opportunity of finding out what engineering is like; the experience assists in the general development of his character, and he enters the university in a more mature state; contact with engineering practice is of the greatest help in giving him an appreciation later of the significance of his theoretical studies; he is accepted by the craftsman and helped in a way that would not be possible if he were an adult.

During the pre-university practical training, study should be continued by part-time attendance at a technical college or works school in mathematics and science and such other subjects as will assist in his university work.

(7) *Duration and Nature of Workshop Training.*—The practical training of the professional engineer cannot be defined narrowly. Practical training should last for from two to five years, depending upon age, qualifications, and experience at the time of entry, and whether or not it is combined with university or part-time technical education. It should include, amongst others, the workshop processes of fitting, operation of machine tools, moulding, pattern-making, and welding. The professional engineering apprentice should spend a short time in the craft apprentice workshop to enable him to acquire a certain understanding of craft problems, not so much with the object of enabling him to attain the standard of dexterity of the craftsman as to familiarise him with workshop practice and to appreciate both the limitations and the possibilities of skilled craftsmanship. His experience in the main shops will give an insight into economic conditions, and an understanding of the outlook of the employees with whom he works and of the employers for whom he works.

The professional engineering apprentice should also have experience in inspection, production organisation, processing, testing, the drawing-office, estimating, and, where possible, in the preparation of contracts and tenders, research, engineering design, installation of plant, &c. For many apprentices it is desirable to give opportunities to gain experience in the maintenance of the plant in the design and manufacture of which they assisted. The completeness of such training is, in some cases, dependent upon co-operation in arranging exchange between different employers.

(*c*) GENERAL

(8) *General Development of Apprentices.*—When the number of apprentices is sufficient,

* Memorandum issued by the Institution of Mechanical Engineers entitled "The White Paper on 'Educational Reconstruction' and Its Impact on Training for Mechanical Engineering."

they should be encouraged to form an association, under its own officers, to develop interests in a wide field, as is accomplished by the more progressive university students' unions. The officers of the apprentice associations should act as a negotiating body with the management on matters relating to apprenticeship training and welfare. In this way a sense of responsibility is developed, and experience is gained of negotiation and committee work of all kinds. Where there are insufficient apprentices to form an association within a single company, the local technical college could provide them with an opportunity to gain experience in operating committees and running affairs by forming a students' association in which they play a part.

SECTION IX.—ESTABLISHMENT OF A POST-GRADUATE COLLEGE

There are inadequate facilities at present for the post-graduate training of established technical staff and executives. The number desiring such advanced training in any one area will always be small, and it is doubtful if either separate universities or technical colleges can make the necessary provision. A post-graduate college should therefore be established to provide courses on a full-time basis. The college should be financed mainly by the State, and should be controlled by an independent self-governing body, but might be developed by addition to one of the large existing and well-established colleges. Although the original charter of the Imperial College of Science and Technology visualised this development, it has never been carried out. Such a college, if established, could do valuable work in many fields on which the following three might be cited as examples :—

(*a*) It could provide courses expounding the latest advances in knowledge in single fields, such as heat transmission, combustion, elasticity, properties of materials, vibration, or the technology of specific developments in modern practice.

(*b*) It could provide courses in administration, organisation, economics, and commerce related to the engineering industry.

(*c*) By constant study of the growing body of knowledge in any particular subject, it could try to bridge the gap between research practice and teaching. It could do this by putting recent developments into teaching form—no easy task in some cases—and thereby reduce the inevitable lag between research, teaching, and practice.

The proposal for a post-graduate college does not exclude the teaching of administration subjects in universities and technical colleges. It is wholly desirable that technical students should be familiar with the groundwork of these subjects.

SECTION X.—CLOSURE

The rehabilitation of our industrial life and the recovery of the export trade essential to our future well-being depend upon our ability to provide an adequate supply of a fully trained professional engineering personnel and craftsmen in the immediate post-war period and upon the utilisation of such men by industry.

To achieve this, the yearly provision of additional training facilities will be necessary.

A commencement should not be deferred until the immediate post-war reconstruction period is upon us.

It is obvious that increased expenditure will be incurred, and in the absence of further explanation and probably of modification, the financial provision of the Appendix of the White Paper will inevitably induce a vigilant and critical mood, stimulated in the first place by the penultimate paragraph of page 34, which reads :—

> "Although the development of technical and adult education *is not included among the matters dealt with in the first four-year plan*, some allowance has been made for preliminary expenditure in respect of technical education."

We have supplied the italics.

Table I of the Appendix to the White Paper shows the additional expenditure from public funds to cover the proposed reforms compared with the last pre-war year, which is estimated to reach an ultimate additional annual cost of £67,400,000.

The interval which is to elapse between the end of the war and the "Appointed Day" on which the new forms commence is not indicated in the White Paper, nor was it foreshadowed in the two days' debate in Parliament which followed its presentation.

We can understand, even if we do not commend, this caution, for certain earlier reforms failed to mature because no appointed day ever arrived for the country as a whole.

We understand, and can commend, the foresight and the courage embodied in the introductory remark of para. 6 of the White Paper, which says :—

> "The rate at which it will be possible to proceed will depend . . . on the financial resources available, having regard to our existing commitments, to the new claims we may have to meet, and to such orders of priority as may have to be laid down."

We conceive it proper and necessary that all the estimates of all the post-war reconstruction plans of all the Ministries be collected, collated, and integrated, and then, by methods well known to mechanical engineers, pass through a process of selection and adjustment in sequence and magnitude to the financial resources and man-hours available.

We are therefore not at this time so much concerned with the absolute value of the total sum of money estimated for "Educational Reconstruction" given in the Appendix, but intensely concerned with the relative values of the allocations and their priorities within the educational reconstruction programme.

The following table is extracted from Table I of the Appendix :—

Let X be an unknown period from the end of war to "Appointed Day."

Time.	Additional expenditure on adult and technical education.	Total additional expenditure.	Part of total additional expenditure devoted to adult and technical education.
	£	£	Per cent.
X+1 year ...	Zero	1,100,000	0·0
X+2 years ...	30,000	2,700,000	1·11
X+3 ,, ...	60,000	9,700,000	0·62
X+4 ,, ...	100,000	17,300,000	0·58
X+5 ,, ...	300,000	24,900,000	1·21
X+6 ,, ...	800,000	32,700,000	2·45
X+7 ,, ...	1,200,000	40,100,000	2·98
X+7+Y* ...	2,700,000	64,400,000	4·03

* Where Y, like X, is an unknown number of years, but is expected to be very much greater than X.

The Parliamentary Secretary to the Board of Education, Mr. Ede, in reply to the debate, stated that "with regard to technical education the figures represent the capital charges on the new buildings," and gave an undertaking to re-examine them in the light of the debate.

But, as will be understood from a reading of the body of this document, we are left with a feeling of disquiet that the Board of Education appears to place undue emphasis on "Buildings" as the end of all technical educational reform.

And if all these moneys are intended to serve building loans alone, where are the estimated sums to cover the numerous collateral reforms effecting improvement in equipment and teaching, the considerable increase in teaching force necessary for increased numbers of students and classes, to increase the efficiency and status of teaching, and to effect the reduction in teaching hours of individual teachers which we have recommended as essential to the achievement of many of these objectives ?

It may well be that there is some provision for technical education in the much more considerably greater funds allocated to Young People's Colleges. This may well be so, since para. 74 of the White Paper, speaking of the hours remaining from the compulsory day-release time after covering physical training, civics, and instruction in written and spoken English, states that "in all appropriate cases the [remaining] time may be used for technical or vocational education related to their employment."

But it would be an undesirable development to strip off from the technical colleges the technical training of youths, up to eighteen, leaving them virtually with work only above ordinary National Certificate standard, and the loss would be even greater to the technical teaching in the Young People's Colleges of the strength and inspiration to be derived from senior work.

Or, again, it may be that since grants to the universities are administered by the Universities Grants Committee and not by the Board of Education, the Government has plans for a considerable increase in the grants to the universities in which scientific and technical departments would certainly share. Whilst these would be welcome as meeting some of the needs to which we have drawn attention, it would certainly not deal with the whole.

The proposed deferment of provision for technical education indicated in the Appendix, together with internal evidence in the White Paper itself, creates the impression that the close relationship between technical education and our industrial survival after the war is not fully accepted by the Board of Education. This may be because officials, expert and trained in this field, either are not available or do not rank sufficiently high in the counsels of the Board to influence the President in the formulation of policies.

The Council of the Institution are of the opinion that the emergence of this country from its relatively backward position in technical education depends largely upon the initiative of administrative officials in the hierarchy of the Board of Education ; and that this initiative is unlikely to be forthcoming unless some amongst the highest of these officials have been technically trained and are expert in the field of technical education.

Finally, the Institution would urge that there shall be no bar to a suitable official trained in science, applied science, or technology becoming Secretary to the Board of Education.

Heat Treatment Plant for Steel Tools

THE L.M.S. Railway has recently installed a plant specifically designed to deal with the heat treatment of high-speed and alloy steel tools. The various practices for heat treatment were carefully investigated before deciding upon the type of furnaces to install, and it was concluded that the salt bath treatment for high-speed steel was best suited for the type of tool to be treated. Other alloy steel tools and reheating of carburised details had to be dealt with differently, and it was decided to install an electrically heated furnace with gas-controlled atmosphere for the treatment of these tools. Fig. 1 shows the lay-out of the shop in normal daylight, and it will be seen that a feature has been made of good illumination, which is a departure from the generally accepted idea that heat treatment shops should be poorly illuminated to help the visual determination of temperatures. After dark the shop is artificially illuminated by fluorescent tubes, which give illumination about equal to that of daylight at the working plane.

The furnaces are arranged in a straight line, and are served by a runway and pulley block over the centre line of the working area of all except the muffle furnace on the extreme right, which has been set back to allow access through the door. To ensure a comfortable working height for the tool hardener, the furnaces are sunk into the shop floor so that the furnace top is at a convenient height for operations, the actual height from floor level to the top of the furnace being 2ft. 6in. The oil and water quenching tanks shown in the foreground have been similarly arranged.

In the sequence of operations, the initial preheat is carried out in the furnace on the extreme left, which is of the forced air circulation type. The tool is then transferred to the next furnace in line, which is a salt bath of refractory material (sillimanite) in which the heating is done by immersed electrodes. Thence

the tool is transferred to a similar salt bath operating at the hardening temperature of 1230 deg. to 1300 deg. Cent., according to the type of high-speed steel being treated. These two salt baths are 24in. deep and have a diameter of 13in. The rectangular quench salt bath for the next operation is 24in. by 18in. deep, to allow sufficient capacity for the accumulation of treated tools which arises at this stage. This bath is heated by two pairs of electrodes, and the inner casing is of mild steel plate. After quenching the tools are allowed to cool on a perforated stillage, which has a tray underneath to catch any molten salt, and they are then passed through a hot swill to remove deposited salt. The final operation is that of secondary hardening, again carried out in a hot air circulating type of furnace.

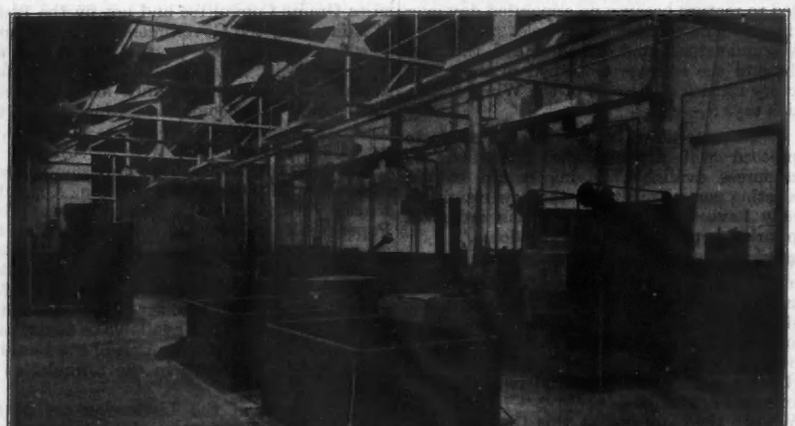


FIG. 1—HEAT TREATMENT SHOP FOR TOOLS

The two furnaces shown on the right are a salt bath furnace (similar to the quench bath described above) used for carburising and an electric muffle furnace with controlled atmosphere. The latter has a Venner time switch in the circuit, switching current on and off at predetermined times. The uptakes carrying the fumes from the salt baths are led to a common duct and thence through the roof. The output of these two furnaces is dealt with in quench tanks of 400 gallons capacity, situated immediately opposite, and a cooling system is incorporated in the oil circuit of the tanks.

FIG. 2—CONTROL PANEL

It was considered that a central control panel, situated at a convenient point, would best serve the requirements of the lay-out, and Fig. 2 shows this control panel. It has been sited opposite the hardening and quench baths, which can be regarded as the nerve centre of the lay-out. The engraving does not reveal the large second hand of the electric clock by which the immersion times in the hardening bath are regulated.

The pyrometers are base-metal thermocouples, with the exception of the one for the hardening bath, which is the standard optical type supplied by Elliott Brothers. The indicators, with two exceptions, are fitted with automatic temperature control. It was not thought necessary for the preheat salt bath, which is not operating at a critical temperature, to have this refinement, and experience has shown that the bath can be regulated successfully by adjusting the tap changes on the transformer. The other exception is the hardening bath, and here, again, adjustment to the working temperature is controlled manually from the transformer. Two recorders are fitted, as will be seen, and these work in conjunction with the secondary hardening furnace and carburising salt bath indicators. Master switches, which can be seen on the panel, under the indicators and recorders, allow of the furnaces being switched off and on without recourse to the main switch behind the furnaces and transformers. Red and green pilot lights, denoting supply on and furnace alive respectively, are also provided.

The sub-station, protected by a grille, is seen on the left-hand side of Fig. 1. It consists of a 750-kVA transformer supplied through 6·6-kV ring main stepping down to a four-wire 440 volts distribution board, and the sub-station components are of a type standardised for the particular works. The high-tension switchgear consists of an oil switch controlling the transformer, which is of the oil-filled, naturally cooled, outdoor type, and two ring main isolators, both of which are normally closed. The ring main is split up at intervals by oil circuit breakers with suitable protecting features, and, generally speaking, feeder switches and feeder isolators are provided for alternative sub-stations. The switchgear is of 150 VA rupturing capacity, of the metal-clad, compound-filled, bus-bar type, with vertical isolation. The low-tension distribution board is of the metal-clad type, individual outgoing circuits being protected by switch fuses or a combination of switches and fuses, according to their size. The fuses are of the totally enclosed, high-rupturing capacity type. The supply to the individual control pillars is taken from bus-bars mounted above them, individual circuits being protected by fuses at the connection to the bus-bars. The supply to the fluorescent lighting units is also taken from these bus-bars.

The furnaces—Fig. 3—were supplied by the Electric Resistance Furnace Company, Ltd., the control panel and pyrometer equipment by Electroflo, Ltd., and the salts for the various salt baths by Edgar Vaughan. The high-tension switchgear was made by the British Thomson-Houston Company, Ltd., the transformer by Electric Construction Company, Ltd., and the low-tension switchgear by the English Electric Company, Ltd. The erection of the plant and the installation of the electrical equipment was carried out by the staff of the Chief Mechanical Engineer's and Electrical Engineer's department. We are indebted to Mr. C. E. Fairburn, M.A., Acting Chief Mechanical Engineer of the L.M.S., for the foregoing information.

FIG. 3—SALT BATH HARDENING FURNACES

FROM HIGHWAY TO PLOUGH LAND.—The harvest now being gathered in the State of Ohio has been made possible by the co-operation of the State Department of Highways, which loaned tractor equipment and workers. More than 900 acres a day were ploughed, disked and harrowed in forty-seven Northern and Central Ohio counties. Not less than 9000 acres of rich Ohio farm lands which otherwise would not have been tilled in time for planting corn were prepared by Highway Department equipment and men within ten days. This is thought to be the first time private farms have been so aided in the United States.

Markets, Notes and News

The prices quoted herein relate to bulk quantities. Unless otherwise specified home trade quotations are delivered f.o.t. Export quotations are f.o.b. steamer.

Swedish Industrial Development

The war has forced Sweden to try to produce within her own territories some of the products which she was formerly able to import or to evolve substitute products for them, states *The Anglo-Swedish Review*, the organ of the Swedish Chamber of Commerce for the United Kingdom. In order to keep the wheels running in many factories, it has been necessary for Sweden to start manufacturing, among other things, machines and tools which were not previously made in the country. The big Swedish electric company A.S.E.A. some time ago completed a plant for the manufacture of electric welding machines of all kinds. While certain types of welding machines, as well as other welding equipment, have been produced in Sweden for many years, welding machines of large types have not been manufactured before. The machines which have been designed by the company are stated to possess a number of technical improvements which make them superior to earlier imported models. The factory is manufacturing no less than 500 different types for practically all kinds of welding. The Lindholmen shipyard of Gothenburg recently launched a motor liner, the ms. "Suecia," of 7400 tons deadweight, for the Swedish Johnson Line. An unusual feature of the ship is that she will be equipped with a reversible and adjustable propeller. This ship will be the largest ocean-going vessel that has been provided with a propeller of this kind. In recent years a number of Swedish tugs, mine-sweepers, and auxiliary vessels have been equipped with propellers of this type, with satisfactory results. The "Suecia" is a combined cargo and passenger carrier and a sister vessel of the "Argentina," previously delivered to the Johnson Line by Gotaverken. The propelling machinery will be installed by Gotaverken, and will develop 8600 I.H.P. It is estimated that it will give the vessel a speed of 17 knots fully loaded. Another vessel for the Johnson Line was recently launched at the Kockum shipyard of Malmo. This latter ship is the "Orinoco," a cargo and passenger carrier of 7900 tons. The Eriksberg Shipyard, of Gothenburg, recently launched a motor liner of 6150 tons deadweight for the Transatlantic Shipping Company. This vessel, the "Bullaren," is of the shelter deck type. The propelling machinery consists of two single-acting, two-stroke, directly reversible "solid injection" diesel engines of the "Trunk" type, developing together 5100 I.H.P.

The Pig Iron Market

The general situation in the pig iron market is satisfactory, and, apart from hematite, there is no great stringency apparent. So far as the ordinary descriptions of foundry pig iron are concerned, the demand keeps the producing works well employed, although it would be possible to meet a heavier demand than the blast-furnaces are experiencing. In the hematite market hopes are still centred upon larger supplies of high-grade ore from North Africa, but although supplies have been received from there, the quantities have not been sufficient to make any marked impression upon the position, and the Control restricts the use of this description to cases in which no other kind of pig iron can be satisfactorily utilised. The heavy engineering foundries are fully engaged on Government work, whilst the jobbing foundries also are busy, principally in making castings for the war effort. Although low-phosphoric pig iron and refined iron is being extensively used as a substitute for hematite, the supply position seems somewhat easier and the Control is allocating weekly quantities of medium and low-phosphoric pig iron to consumers, and is adopting the same method of distribution in the case of hematite. The Control sees to it that the foundries engaged on Government work are kept fully supplied so that there is no decline in the production of urgently required materials. High-phosphoric iron, which is in liberal supply, is being used extensively for many purposes for which before the war it was not considered suitable, but there is a limit to the uses to which this description can be applied in foundry mixtures, and the demand does not fully absorb the production. The light castings foundries which normally are the chief users of this kind of iron experience no difficulty in obtaining their full requirements, but it has not been found possible fully to incorporate this branch of the industry in the war effort. A number of light castings firms, however, are engaged in making castings required for Service needs, and recently this branch has been better occupied than since the war commenced. Recently the supply position of the high-phosphoric qualities of pig iron has been so good that it has been possible to lay a number of blast-furnaces idle for repairs and relining.

Scotland and the North

The Scottish steel works are meeting the tremendous demand, but are able to maintain full supplies to consumers engaged upon essential work. The shipyards continue to call for huge tonnages of plates and recently the emphasis has been upon the thinner sorts. The sheet makers are assisting in meeting this request by producing big tonnages of thin plates. There is a strong demand for light and structural sections, but the heavier descriptions are not more than in moderate request. The quantities of alloy steel passing into consumption are probably unprecedented, but there are few signs of stringency in the market, since the Control has devoted its efforts to increasing the output of this description. Although the bar iron makers have been fairly busy recently, the demand is not to be compared with that for steel bars. Many cases of orders having been diverted from steel to iron have been heard of lately, owing to the earlier delivery dates obtainable for the latter description. Marine engineers in Scotland are practically all engaged to capacity, and their requirements of steel are an outstanding feature of the position, whilst some important orders for plates have been placed by locomotive builders. A heavy volume of business is passing in steel bars, although the call for ferro-concrete bars, which was a feature of the market not long ago, has fallen off considerably. The engineering industry is taking big supplies of large-diameter bars, whilst the re-rollers are experiencing an insistent call for the smaller sizes. Recently some irregularity has been noticeable in the Lancashire market as regards delivery conditions and some works appear to be better situated than others. The demand for alloy steel has been maintained at a high level and big quantities are passing into consumption by the aircraft and armaments manufacturers. The collieries continue to take big quantities of props and arches, but the makers are able to maintain a continuous flow of supplies. The steel works on the North-West Coast are operating at capacity in meeting the demand of the war industries. They have well-filled order books and their output for the next few months is earmarked.

The North-East Coast and Yorkshire

Now that the holidays are over the steel works on the North-East Coast are able to devote their maximum efforts to maintaining supplies to consumers engaged in meeting essential war needs. The raw materials position is entirely satisfactory and, so far as can be seen, is better than at any time during the past two years. The semi-finished steel position has been quite good for the last month or two and the re-rolling industry is receiving all the billets and sheet bars that it needs. The billet position, in particular, has been improved lately by the Control's action in diverting some productive capacity that was formerly engaged in making sheet bars on to billets. Good quantities are reaching English works from South Wales, as well as from English producers. Although the output of sheet bars is less than even a few weeks ago, the sheet makers are not experiencing any shortage in supplies. If there is any tightness in the semi-finished position it is in flat billets, although this is generally thought to be a temporary phase. The re-rollers have heavy order books extending to the end of the year and beyond, and the Control is making adequate arrangements to cover their requirements of semi-finished steel. The plate position is tight and most of the works producing this class of material have congested order books. Large quantities are required by the shipyards, the wagon and tank makers and heavy engineers. Most of the sheet works also have substantial contracts in hand for thin plates. The demand for structural steel is maintained at a high level and arises largely from Government contracts. Most of the works producing sections are fully employed and have enough work in hand to keep them busy until well into the first quarter of 1944. The demand for steel bars is strong and large tonnages of the larger sizes are passing into consumption. All the Yorkshire steel works are fully engaged now that the holidays are over, and practically all departments are equally busy. The call for basic steel is unrelaxed, and there is a continuous demand for acid carbon steel which is straining the resources of the producing works. The volume of business in heavy structural steel does not noticeably improve, but the demand for the lighter sizes is keeping the producing works operating at capacity. It is not easy to place orders for sheets for delivery before the fourth period, and many of the works are booked up until early next year. The sheet makers, however, are well situated so far as their supplies of sheet bars are concerned.

The Midlands and South Wales

The Midland iron and steel industries have now settled down following the holidays to a spell of very intensive working. In practically all departments of the industry the demand for materials arising from the war shows signs of gathering volume. Here and there, it is true, there is a slight slowing down of activity, but this is generally due to some temporary cause, and does not affect the outlook of the industry as a whole. There is no change in the steel plate position. The works producing this class of material, one and all, are operating at capacity, and their whole production is mortgaged until well into next year. For a little time now there has been a particularly heavy demand for thin plates, and the sheet makers have done much to meet this call. The shipyards are the heaviest consumers, as they have been for many months, but good quantities are also passing to the tank makers, wagon builders, and the heavy engineering industry. There has also been a considerable business in plates for locomotives. A heavy volume of business is passing in steel bars, and although there has been a strong demand for some time for the larger diameters, lately there has been some increase in the call for small steel bars, which has kept the re-rolling works actively engaged. The demand for reinforced concrete bars is steady, but there is less pressure in this department than there was a month or two ago. There is a steady and strong request for alloy steel from the aircraft and armaments manufacturers, as well as from the machine tool makers. The volume of business in structural steel has been maintained at a high level for a long time, and there seems little likelihood of there being any immediate decrease. The demand for heavy joists and sections, however, has little life in it, and interest in this department centres principally upon smaller sizes. Great activity characterises the South Wales iron and steel industry. The tinplate works are fully employed, so far as the regulations permit, but export business remains at a minimum. There has been some improvement in the demand for tinplates in the home market, the principal call being for unassorted tinplate base uncoated plates. There has been a rather weak demand for terne plates and only a moderate business has passed in black plates. The makers of cold rolled strip are fully occupied, and the sheet mills are assured of busy conditions until well after the end of the year.

Iron and Steel Scrap

The scrap market seems to be throwing off the rather apathetic conditions which have ruled for the last week or two, largely as a result of holiday influences. The character of the demand, however, does not appear to have changed, and consumers are still anxiously seeking the heavier and better classes of scrap. There does not appear to have been any slackening in the heavy consumption, and Mr. George Hicks, Joint Parliamentary Secretary to to Ministry of Works, in inaugurating a scrap drive in Berkshire, said the 450,000 tons of railings had gone to the steel works, and that 2,800,000 tons of scrap had been collected, but the reserves held were still small, and they must not pause in the task of getting scrap to the mills and foundries. Mr. H. W. Secker, Director of Scrap Supplies, Iron and Steel Control, said that 1000 tons of scrap an hour were being used and that heavy scrap was urgently needed. It is understood that the imports of scrap have ceased. There is, however, a strong demand for the better grades of steel melting scrap. Wagon labels have been issued with greater freedom of late. Good heavy mild steel scrap, cut to furnace and foundry sizes, is still scarce, and consumers readily pick up any parcels coming on the market. A considerable business is passing in bundled steel scrap and hydraulically compressed steel shearings, and the demand is sufficient quickly to absorb the whole output. There is no scarcity of mild steel turnings, but at the same time the heavy and prepared grades are steadily taken up. Other qualities, particularly bushy turnings, are in poor request. Recently consumers have shown more interest in compressed basic bundles, and on the whole the demand for this description is satisfactory. Recently the volume of business in this quality has improved. Heavy cast iron in large pieces and furnace sizes has attracted more interest of late, and consumers are not finding it so easy to cover their requirements as even a few weeks ago. Only limited quantities of light cast iron scrap are available, and there is an active business in parcels that come on the market. Heavy machinery cast iron scrap is in good demand, and an active business is passing with the foundries. In fact, most descriptions of cast iron scrap find a ready market.

Notes and Memoranda

Rail and Road

CHILE COMPLETES A BRIDGE.—A bridge which has been under construction for approximately seven years across the Bio-Bio River, near Concepcion, Chile, has been brought into service. It connects the Santiago and Concepcion highway with the Province of Arauco.

BRITISH COLUMBIA'S NEW BRIDGE.—A new high-level bridge with a 24ft. roadway has been built for traffic across the Peace River, between Dawson Creek and Fort St. John. It will replace two temporary bridges that were carried away by high water. The bridge is one of the many undertakings in connection with the construction of the 1600-mile Alaska Highway.

GERMAN LOCOMOTIVES FOR TURKEY.—Fifteen austerity locomotives have been delivered by Germany to Turkey under the trade agreement made some months ago. Also in accordance with the Turkish-German trade agreement, 150 wagons have arrived at Istanbul from Germany. Negotiations between the two countries are reported for the supply of an additional 15 locomotives and 500 wagons. Meantime, Turkey has taken delivery of five locomotives from the U.S.A.

FUEL ECONOMY ON THE RAILWAYS.—Representatives of the Railways' Fuel Efficiency Committee recently met the Fuel Efficiency Committee of the Ministry of Fuel and Power, and plans were discussed for a still greater drive for fuel economy which the railways are hoping to make in the coming winter. It was announced that a meeting to inaugurate the new drive is to take place towards the end of September. Sir James Milne, Chairman of the General Managers' Conference, will preside, and Major Lloyd George, Minister of Fuel and Power, will address the meeting.

CHICAGO RAILWAY HISTORY.—Ten tons of general office records and correspondence of the Chicago, Burlington and Quincy Railroad for the period 1850 to 1887 have been deposited with the Newberry Library, Chicago, so that details of the creation and development of the railway will be available to qualified students and writers. *Railway Age* says that these records include correspondence of the pioneers who founded and built the railway and directed its policy during its first thirty-seven years, as well as files relating to the construction, operation, and finance, and many items of local and biographical interest. It is believed that the records will provide enlightening and in many instances new commentaries on the economic beginnings of the country, as well as on the social customs, the level of technological knowledge, and the business strategy of those early days. The records contain details of the Burlington's origin in the little 12-mile Aurora branch railway; the formation of the Chicago, Burlington and Quincy, through the consolidation of several Illinois lines; the extension to the Mississippi River in 1855; the origin and construction of the Hannibal and St. Joseph line, first to reach the Missouri River in 1859; the extension of the main line across Iowa during the difficult periods immediately preceding and following the Civil War; the construction of the Burlington line across Nebraska to reach Denver in 1882; and the building of the Twin Cities line to St. Paul in 1885–86.

Air and Water

CREWE MAY HAVE AN AIRPORT.—The Cheshire County Council is promoting a scheme to provide for a terminal airport at Crewe. If it goes through, the railway station and the airport would be linked directly by a subway, which would facilitate the movement of passengers between station and aerodrome.

AUSTRALIAN HYDRO-ELECTRIC PROJECT.—The construction of the largest hydro-electric scheme in Australia on the Snowy River is scheduled as a first post-war project. At an estimated cost of £11 millions, the scheme is expected to produce power and distribute it by grid system over Victoria and New South Wales.

VENEZUELA AS AN OIL COUNTRY.—The war has done much to increase the Venezuelan petroleum industry. A record in oil production was achieved in 1941, with output soaring to 33,353,770 metric tons, thus placing Venezuela second among the world's oil-producing countries. The 1941 production represented an increase of 21·5 per cent. over the 1940 output.

"BLIMP" HANGARS.—It is claimed that the U.S.A. Navy is building "blimp" hangars which are the largest structures ever to be built entirely of timber. In plan they have overall dimensions of 1060ft. by 297ft., and a clear, unobstructed interior area of 1000ft. by 237ft., with a clear height of 153ft. The roof decking is 2in. plank, which is covered with composition roofing. The floor is of concrete.

Miscellanea

CUBA TO PROVIDE NICKEL.—It is reported that the large deposits of low-grade nickeliferous iron ores blanketing the wooded plateaux of North-Eastern Cuba are to be treated by a complicated process to yield nickel for armour plate and other special steels which are required for the war effort.

CANADA AND SYNTHETIC RUBBER.—July saw the beginning of operations at the Polymer Corporation's synthetic rubber plant in Sarnia, Ont., when crude styrene was manufactured by the Dow Chemical Company of Canada. Within a few weeks a distillation unit is expected to be completed. Much of the Polymer plant is still under construction and the styrene now being made will be utilised in the United States.

MICA FROM CEYLON.—The mica now being obtained from Ceylon has received a good report. Practically the whole of the output has been purchased for the requirements of the United Nations. Some of the Ceylon mica mines are reported to be producing mica equal to the best in the world, and when local labour has been better trained to trim and grade the mica, Ceylon should rank among the important producing countries.

BAUXITE IN AUSTRALIA.—There are adequate supplies of high-grade bauxite in Australia, and if plant could be obtained from overseas the Commonwealth Government might initiate a plan to produce 10,000 tons of aluminium a year in Australia. The estimated cost of establishing the industry is put at £3,000,000. So far, efforts to obtain the necessary plant, such as electrical and smelting machinery, from the United States have failed.

THE LATE MR. F. M. BAILEY.—We regret to learn of the death on August 25th of Mr. Frederick Mandley Bailey, managing director of Sir W. H. Bailey and Co., Ltd., Albion Works and Ellesmere Foundry, Patricroft, Lancashire. Mr. Bailey was the last surviving son of Sir W. H. Bailey and a grandson of the founder of the firm which was established in 1839. No doubt the total destruction by enemy action of the firm's former premises in Salford had its effect on Mr. Bailey's health. This destruction occurred in 1940, up to which date the firm had occupied land in Oldfield Road, Salford, for over 100 years.

ENGINEERING ECONOMICS.—A course of three lectures and discussions on "Engineering Economics," by Sir Frank Gill, will be held at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, W.C.2, on Tuesdays, at 5.30 p.m., beginning September 21st, 1943. Outline syllabus of the course:—September 21st, Lecture I: What is engineering? Engineering economics common to all engineers as regards necessity and form. Logical process of design in both preliminary and final stages. Elements of subject, data, and methods to be used. September 28th, Lecture II: Designing plant to specific requirements, to be constructed on site. Preliminary examples. Specific examples. October 5th, Lecture III: Designing plant to general requirements, as for manufacture. Specific examples. Fees: For the course of three lectures, 2s. 6d.; admission to single lectures, 1s. Applications for tickets of admission to the course should be addressed to the Accountant, University of London, the Senate House, Bloomsbury, W.C.1, and marked "Extension Lectures" on the cover. Tickets may also be obtained at the lecture room on the occasion of each lecture.

THERMOPLASTIC CABLES.—In connection with the note on thermoplastic cables which appeared in our issue of August 20th, Mr. J. F. Kenure, managing director of Duratube and Wire, Ltd., Feltham, Middlesex, has written to us with the object of pointing out that the Cable Makers' War Emergency Technical Committee does not embrace all manufacturers of thermoplastic covered wires and cables. In the note it was stated that P.V.C. cables would give satisfactory service under most conditions as substitutes for war emergency rubber cables for general wiring work. Mr. Kenure thinks that this statement may create a wrong impression, in that it seems to suggest that P.V.C. cables are inferior products and only good enough for a short life under wartime conditions. Nevertheless, he seems to be in full agreement with the Committee in holding that there *are* some conditions under which P.V.C.-covered cables are not suitable substitutes for other materials, and that further investigation is desirable in order to develop their general utility for peacetime work. Mr. Kenure maintains that in doubtful cases, intending users of P.V.C. cables should seek the advice of the Cable Planning Officer of the Ministry of Supply, and that the existence of a private advisory body can only create confusion.

PLASTIC WATER PIPES.—Canada is now manufacturing plastic pipe in sizes up to 1¼in. diameter. Plastic pipe has been used as underground water pipe in the United States, and diameters up to 6in. are expected in the near future. Among its advantages are its light weight, which is only about 18 per cent. of that of cast iron pipe of a similar wall thickness. Freezing of water within the pipe does not occur, and the pipe is immune to corrosion. It can be tapped and threaded in a similar manner to metal pipe.

A WELDED CHIMNEY STACK.—The engineers of a U.S.A. war factory made welding history when they constructed two urgently needed chimneys of steel. The stacks, each 150ft. high and 5ft. in diameter, were erected in one-third less time than normally would be required. Made of low-carbon, ¼in. steel sheets, the stacks were built in 5ft. sections weighing approximately 850 lb. each. For the first 100ft. of installation, two sections were welded together in the shop, then erected as a single unit and welded in position. During the last 50ft., however, each 5ft. section was mounted separately, to simplify handling operations. All joints were fillet welded and approximately 1200 lb. of ⅛in. electrodes were used.

Personal and Business

LORD DUDLEY GORDON has been elected a director of Hadfields, Ltd.

BUTTERS BROTHERS AND CO., Ltd., inform us that their London office has been transferred to 64, Drax Avenue, Wimbledon, S.W.20 (telephone, Wimbledon 2295–6).

C. A. PARSONS AND CO., Ltd., have opened an office at Litfield House, Litfield Place, Clifton, Bristol, 8, and have appointed Mr. J. L. Packard as representative for the area.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

Association of Public Lighting Engineers

Wednesday and Thursday, Sept. 22nd and 23rd.—Inst. of Mechanical Engineers, Storey's Gate, Westminster, S.W.1. Two day conference.

Association of Special Libraries and Information Bureaux

Saturday and Sunday, Sept. 18th and 19th.—Royal Society, Burlington House, Piccadilly, W.1. Annual conference. 10.30 a.m. (Saturday and Sunday).

Institute of Economic Engineering

Sunday, Sept. 12th.—Waldorf Hotel, Aldwych, W.C.2. "Laminated Steels," Mr. Gardner. 2.30 p.m.

Institute of Marine Engineers

Tuesday, Sept. 14th.—Inst. of Mechanical Engineers, Storey's Gate, Westminster, S.W.1. Presidential Address, "Experience Teaches: An Account of Some Difficulties Experienced with Machines and Men, with Some Reflections Thereon," Eng. Vice-Admiral Sir George Preece. 5.30 p.m.

Institution of Production Engineers

Friday, Sept. 17th.—WESTERN SECTION: Grand Hotel, Broad Street, Bristol. "Quality Control," K. W. Macartney. 6.30 p.m.

Junior Institution of Engineers

To-day, Sept. 10th.—39, Victoria Street, Westminster, S.W.1. "The New Civilisation in China," C. A. Middleton Smith. 6.30 p.m.

Friday, Sept. 24th.—39, Victoria Street, Westminster, S.W.1. "Daylight Illumination in Factories and Workshops," P. J. Waldram. 6.30 p.m.

Royal Aeronautical Society

Wednesday, Sept. 15th.—GRADUATES SECTION: 4, Hamilton Place, W.1. "Aircraft Woods," Mr. Nelhersh. 7.30 p.m.

Wednesday, Sept. 22nd.—GRADUATES' AND STUDENTS' SECTION: 4, Hamilton Place, W.1. Informal talk by Sir Frederick Handley Page. 6.30 p.m.

Society of Individualists

Thursday, Sept. 16th.—College of Preceptors, Bloomsbury Square, W.C.1. "Culture and Liberty," Sir J. Martin-Harvey. 2.30 p.m.